

## Appendices



Photo Courtesy of Virginia Save Our Streams

# **Appendix 1**

## **Contacts**

## Virginia Citizen Water Quality Monitoring Program Contacts

Alliance for the Chesapeake Bay  
<http://www.AllianceChesBay.org>  
[smoulds@acb-online.org](mailto:smoulds@acb-online.org)  
(804) 775-0951  
PO Box 1981  
Richmond, VA 23218

Virginia Department of Environmental Quality  
<http://www.deq.state.va.us/cmonitor>  
[jfbrooks@deq.state.va.us](mailto:jfbrooks@deq.state.va.us)  
(804) 698-4000 or toll free in Virginia (800)  
592-5482  
P.O. Box 10009  
Richmond, VA 23240

Virginia Department of Conservation &  
Recreation  
<http://www.dcr.state.va.us>  
203 Governor St., Suite 206  
Richmond, VA 23219

Virginia Save Our Streams Program  
<http://vasos.org>  
[vasosoffice@vasos.org](mailto:vasosoffice@vasos.org)  
(540) 377-6179/toll free (888) 656-6664  
7598 North Lee Highway  
Raphine, VA 24472

## Other Contacts Mentioned in Manual

Appomattox River Water Quality  
Monitoring Program  
Clean Virginia Waterways  
Longwood University  
<http://web.lwc.edu/cleanva/>  
[Ccleanva@longwood.edu](mailto:Ccleanva@longwood.edu)  
(434) 395-2602  
Dept. of Natural Sciences  
Farmville, VA 23909

Ferrum College  
Smith Mountain Lake and Claytor Lake  
Water Quality Monitoring Programs  
<http://www.ferrum.edu/waterqual/sml/index.htm>  
[djohnson@ferrum.edu](mailto:djohnson@ferrum.edu)  
Ferrum, VA

Assateague Coastal Trust  
<http://www.actforbays.org>  
[mail@actforbays.org](mailto:mail@actforbays.org)  
(410) 629-1538  
Box 731  
Berlin, MD 21811

Friends of Powhatan Creek Watershed  
<http://www.widomaker.com/~watershed>  
[watershed@widomaker.com](mailto:watershed@widomaker.com)  
403 Neck O'Land Road  
Williamsburg, VA 23185

Audubon Naturalist Society  
<http://www.audubonnaturalist.org/rustsanct.htm>  
(703) 803-8400  
Web Sanctuary  
P.O. Box 51  
Clifton, VA 22207

Friends of the Shenandoah River  
<http://www.fosr.org>  
[kanderse@su.edu](mailto:kanderse@su.edu)  
(540) 665-1286  
Shenandoah University  
1460 University Drive (Gregory Hall)  
Winchester, VA 22601

James River Association  
<http://www.jamesriverassociation.org>  
[keeper@jamesriverassociation.org](mailto:keeper@jamesriverassociation.org)  
(804) 730-2898  
P.O. Box 909  
Mechanicsville, VA 23111

Lake Anna Civic Association  
[http://www.lakeannavirginia.org/  
WaterQuality.htm](http://www.lakeannavirginia.org/WaterQuality.htm)  
P.O. Box 217  
Lake Anna, VA 23117-0217

Loudoun Soil & Water Conservation  
District  
<http://www.loudoun.vaswcd.org>  
[loudoun-swcd@va.nacdnet.org](mailto:loudoun-swcd@va.nacdnet.org)  
30 Catocin Circle, S.E., Suite H  
Leesburg, VA 20175  
(703) 777-2075

Loudoun Wildlife Conservancy  
<http://www.loudounwildlife.org>  
P.O. Box 2088  
Purcellville, VA 20132-2088

Mattaponi and Pamunkey Rivers Association  
<http://www.mpra.org>  
(804) 769-0841  
P.O. Box 157  
Walkerton, VA 23177

Northern VA Soil & Water Conservation District  
<http://mason.gmu.edu/~jarcisze/StreamMonitoring>  
[jarcisze@gmu.edu](mailto:jarcisze@gmu.edu)  
(703) 324-1425  
12055 Government Center Pkwy #905  
Fairfax, VA 22035-5512

Upper Rappahannock Watershed Stream  
Monitoring Program  
<http://www.rappmonitor.va.nacdnet.org>  
[rappmonitor@yahoo.com](mailto:rappmonitor@yahoo.com)  
(540) 937-3934

## **Appendix 2**

### **Letter of Agreement**

## **Letter of Agreement to Implement the Virginia Citizen Water Quality Monitoring Program**

The Alliance for the Chesapeake Bay;  
The Virginia Department of Conservation and Recreation;  
The Virginia Department of Environmental Quality; and  
The Virginia Division Izaak Walton League of America,  
Virginia Save Our Streams Program

### **Purpose**

The Alliance for the Chesapeake Bay (ACB); the Virginia Department of Conservation and Recreation (DCR); the Virginia Department of Environmental Quality (DEQ); and the Virginia Division Izaak Walton League of America, Virginia Save Our Streams Program (IWLA VA SOS) are dedicated to supporting the Virginia Citizen Water Quality Monitoring Program throughout the Commonwealth for the purpose of collecting useful water quality information and encouraging environmental stewardship. We recognize that cooperative efforts enhance Virginia's ability to protect and restore the Commonwealth's water quality while also strengthening citizen commitments to water quality issues on a local level. While many government agencies and other organizations participate in and support this cooperative effort, this Letter of Agreement defines the roles of the agencies, ACB, and the IWLA VA SOS in the implementation of the Virginia Citizen Water Quality Monitoring Program. We have entered into this agreement with the understanding that combined efforts are less duplicative and can produce greater and more consistent benefits for the common good.

### **Goals**

#### **Support Citizen Water Quality Monitoring Efforts Statewide:**

We will work to support the Citizens for Water Quality (CWQ), a statewide consortium of citizen groups, agency representatives, businesses, and individuals interested in preserving and enhancing Virginia's water resources. We will facilitate communication among citizen water quality monitoring groups across Virginia, as well as communication between those groups and state agencies. We will participate in the Virginia Water Monitoring Council. We will provide and support training opportunities on water quality issues. We will continue to identify new partnerships and funding sources to support existing monitoring groups and stimulate new ones.

#### **Promote Appropriate Quality Assurance and Quality Control:**

We will identify appropriate water quality sampling protocols, publish the protocols in the Virginia citizens monitoring methods manual, and provide training on these protocols. We will develop a collaborative strategy to promote the need for and the development of quality assurance project plans in accordance with data use goals. We will provide guidance and support to citizen water quality monitoring groups in the development of quality assurance project plans.

**Promote the Use of Citizen Water Quality Data in Virginia:**

We will promote the use of citizen water quality data as described in the section titled, “Citizen Data in Virginia.” We will include citizen water quality data in water quality assessments as appropriate. We will seek appropriate new uses for citizen-generated water quality data in Virginia.

**Promote Partnership and Collaboration Among Citizen Water Quality Monitoring Efforts:**

We will promote collaboration among organizations involved in citizen water quality monitoring efforts. We will work to expand and support existing partnerships and build new relationships. We will seek opportunities to improve dissemination of information and increase involvement in environmental stewardship activities.

**Signatory Responsibilities**

**Alliance for the Chesapeake Bay**

ACB will continue to provide training to citizen monitors in water quality monitoring methods, provide quality assurance oversight for participating volunteers and assist in identifying new opportunities for citizen stewardship activities. ACB will continue to promote citizen stewardship efforts and will assist in locating citizens and citizen organizations desiring to participate in citizen water quality monitoring and related activities. ACB will assist organizations in identifying sources of funding and organization development.

**Virginia Department of Conservation and Recreation**

As part of the Department’s statewide responsibilities, DCR will provide technical expertise and general information on matters concerning nonpoint source pollution. In cooperation with DEQ, DCR will provide technical expertise and general information on Total Maximum Daily Load development. DCR will provide technical expertise and general information on planning citizen water quality monitoring programs. DCR will promote the use of citizen data to meet the Commonwealth’s water quality data needs and will assist in identifying appropriate uses for citizen-generated data. DCR will promote the delivery of citizen stewardship activities on a watershed basis and will work to identify new opportunities for citizen stewardship efforts. DCR will work to engage citizens and citizen organizations in water quality monitoring and related stewardship activities. DCR will continue to provide technical expertise and general information on grant writing, sources of funding, public outreach techniques, organization development, and marketing.

**Virginia Department of Environmental Quality**

As part of the Department’s statewide responsibilities, DEQ will provide technical expertise and general information on matters concerning point source pollution. In cooperation with DCR, DEQ will provide technical expertise and general information on Total Maximum Daily Load development. DEQ will continue to provide technical expertise and general information about monitoring water quality including monitoring protocols, planning water quality monitoring programs, existing agency monitoring locations, site selection, data management, and quality assurance and quality control measures. DEQ will maintain the Virginia citizens monitoring methods manual and may provide citizen water quality monitoring grants to support citizen efforts. DEQ will promote the use of citizen data to meet the Commonwealth’s water quality

data needs and will assist in identifying appropriate uses for citizen-generated data. DEQ will continue to assist in identifying new opportunities for citizen stewardship efforts.

### **IWLA Virginia Save Our Streams**

IWLA VA SOS will continue to provide training to citizen monitors in water quality monitoring methods, provide quality assurance oversight for participating volunteers and assist in identifying new opportunities for citizen stewardship activities. IWLA VA SOS will continue to promote citizen stewardship efforts and will assist in locating citizens and citizen organizations desiring to participate in citizen water quality monitoring and related activities. IWLA VA SOS will assist organizations in identifying sources of funding and organization development.

### **Citizen Water Quality Data in Virginia**

We recognize that citizen water quality data has many uses in Virginia depending on the needs of the citizen monitoring group, the type of monitoring protocols used, and the completeness of the monitoring quality assurance project plan. We further recognize that the use of citizen water quality data as evidence in enforcement actions is not appropriate.

#### **Education**

Citizen water quality monitoring data can be used both in a classroom setting and as an educational tool for community members. In the classroom, monitoring activities instruct students about the scientific method, water quality indicators, and water pollution. In the community, citizen water quality monitoring connects interested citizens to the local water quality conditions. It provides a framework for understanding diverse sources and types of degradation and the benefits of best management practices (BMPs).

#### **Baseline Information**

Citizen water quality monitoring data, including chemical, biological, and physical, can be used to establish background conditions and prioritize monitoring needs. The most useful data is collected in association with a quality assurance project plan.

#### **Local Land Use Decisions**

Citizen-generated data can contribute to local land use decisions in practical ways. Data can document existing conditions and support the local decision-making process. Similarly, citizen-generated data can document water quality improvements resulting from local actions such as implementation of BMPs.

#### **Red Flag for Pollution Events**

Citizen-generated data that indicates unusual conditions for the site can be an indicator of changes in land or resource management that are affecting local water quality. Citizen water quality monitoring can identify initial changes in resource management that can affect water quality as well as acute water quality conditions such as toxic events.

#### **Special Studies**

Citizen water quality monitoring data can be used to document water quality improvement projects and short term, special projects.

### **Assessment Information**

Citizen water quality monitoring data collected under DEQ-approved quality assurance project plans are used by DEQ in statewide water quality assessment reports. This data is included in the 305(b) Water Quality Assessment Report and may be included on the Virginia Impaired Waters List.

### **Period of Performance**

This Letter of Agreement continues the collaborative partnership begun in 1998 and reaffirmed in the 1999 Letter of Agreement among DEQ, DCR and IWLA VA SOS. The Virginia Citizen Water Quality Monitoring Program continues to evolve to meet the needs of the Commonwealth and, in this light, ACB is joining as a new signatory to the agreement. This document reflects the signatories' plan for cooperative efforts and should not be construed as a binding contract. Any party may leave this cooperative program at any time and for any reason. Performance of this agreement will continue for a period of 24 months, at which time the agreement will be reviewed and renewed, upon mutual agreement of the signatories.

Nothing in this agreement prohibits ACB, DCR, DEQ, or the IWLA VA SOS from entering into similar agreements with other organizations. Nothing in this agreement prohibits ACB, DCR, DEQ, or the IWLA VA SOS from implementing other programs for which they are responsible. Additional parties may be added to this agreement upon the mutual consent of the signatories.

We, hereby, agree to the conditions described herein:

**Alliance for the Chesapeake Bay**

By:

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Title: David B. Bancroft, Executive Director  
Alliance for the Chesapeake Bay

Date:

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**Virginia Department of Environmental  
Quality**

By:

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Title: Robert G. Burnley, Director, Virginia  
Department of Environmental Quality

Date:

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**Virginia Department of Conservation and  
Recreation**

By:

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Title: Joseph H. Maroon, Director, Virginia  
Department of Conservation and Recreation

Date:

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**Izaak Walton League of America**

By:

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Title: Jay Gilliam, Virginia Save Our  
Streams Coordinator

Date:

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By:

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Title: Jay Bolton, President, Virginia  
Division Izaak Walton League of America

Date:

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## **Appendix 3**

### **Legislation Establishing the Virginia Citizen Water Quality Monitoring Program in the *Code of Virginia***

## **Legislation Establishing the Virginia Citizen Water Quality Monitoring Program in the *Code of Virginia***

### **HB497 Text as Enacted by the General Assembly of Virginia**

*Code of Virginia §62.1-44.19:11. Citizen water quality monitoring program*

*The Department of Environmental Quality shall establish a citizen water quality monitoring program to provide technical assistance and may provide grants to support citizen water quality monitoring groups if (i) the monitoring is done pursuant to a memorandum of agreement with the Department, (ii) the project or activity is consistent with the Department of Environmental Quality's water monitoring program, (iii) the monitoring is conducted in a manner consistent with the Virginia Citizens Monitoring Methods Manual, and (iv) the location of the water quality monitoring activity is part of the water quality control plan required under § 62.1-44.19:5. The results of such citizen monitoring shall not be used as evidence in any enforcement action.*

## **Appendix 4**

# **Template for Submittal of Citizen Monitoring Data to the Virginia Department of Environmental Quality**

## **Instructions for Submittal of Citizen Monitoring Data to the Virginia Department of Environmental Quality (DEQ)**

1. All data should be submitted electronically in an Excel spreadsheet or compatible format using the appropriate attached template (for chemical or macroinvertebrate monitoring).
2. All data should be included in one worksheet. Each monitoring event (site, date, time) should be entered in a separate line of the data file.
3. Use the attached template without moving or deleting columns. If you do not monitor one or more of the basic parameters included in the attached template, please leave the associated columns blank. If you need to add columns for additional parameters, please do so on the right hand side of the spreadsheet.
4. Major Watershed: Indicate the major river basin where the site is located. Use the following major river basin identifications: (1) Shenandoah/Potomac, (2) James, (3) Rappahannock, (4) Roanoke, (5) Chowan River/Dismal Swamp, (6) Tennessee/Big Sandy, (7) Chesapeake Bay and Small Coastal Basins, (8) York, and (9) New.
5. Stream Name: Indicate the name of the stream that the station is actually located on, as identified from a USGS topographic map or other standard reference. If the site is on an unnamed tributary to a named stream, please state “Unnamed tributary to (*insert name of stream*)”.
6. Station Number: This number should be unique for each station monitored by a specific citizen or citizens’ group. The station number for a station should not change from one sampling event or data submittal to another.
7. DEQ ID Number: This number will be assigned by DEQ. Once a DEQ ID Number is assigned for a station, it should be included in all subsequent data submittals to DEQ to facilitate data use by the agency.
8. Station Location Description: Include a detailed station location description, so the station can be located on a map (*e.g.*, Rt. 619 bridge or 0.5 miles downstream of Rt. 619 bridge).
9. County: Indicate county where station is located.
10. Latitude/Longitude: If station lat/long is in degrees/minutes/seconds, enter these units in the appropriate columns and leave the decimal degrees columns blank. If lat/long is in decimal degrees, enter these units in the appropriate columns and leave the degrees/minutes/seconds columns blank.
11. Collection Date: Indicate data sample collected in MM/DD/YY format
12. Collection Time: Indicate time sample was collected. If time of collection is not part of your normal data record, you may leave this column blank.

13. Water Temperature: If water temperature is measured, enter the value in this column. If this parameter is not measured, leave column blank. Indicate units (°F or °C) in the parentheses of the field name, but do not include units beside each value. Do NOT enter anything other than numbers (or a negative sign if needed) in this column. If any additional information about the specific value is required (e.g., <, ≤, >, ≥, ±, etc.), describe the value and parameter in the “Comments” column.
14. pH: If pH is measured, enter the value in this column. If this parameter is not measured, leave column blank. Do NOT enter anything other than numbers in this column. Additional information about the specific value should be entered in the “Comments” column.
15. Dissolved Oxygen (DO): If DO is measured, enter the value in this column. If this parameter is not measured, leave column blank. Do NOT enter anything other than numbers in this column. If any additional information about the specific value is required (e.g., <, ≤, >, ≥, ±, etc.), describe the value and parameter in the “Comments” column.
16. Comments: If you need to enter any additional information about the sampling event or any of the values obtained, please do so here. For example, stream conditions (dry, low, normal, flood, etc.), weather (clear, overcast, heavy clouds, raining, etc.) and wind (calm, breezy, windy, etc.) are often very useful in interpreting monitoring data.

Citizen Monitoring Macroinvertebrate Data Submittal Template

Major River Basin	Stream Name	Station #	DEQ Station ID	Station Location Description	County	Latitude Degrees	Latitude Minutes	Latitude Seconds	Longitude Degrees	Longitude Minutes	Longitude Seconds
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Latitude Decimal Degrees	Longitude Decimal Degrees	Collection Date (mm/dd/yy)	Collection Time (24hr – xx:xx)	Water Temperature Value (Units)	Stream Quality Rating	(Organism Name) Count	Comments	Etc.
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**Citizen Monitoring Chemical Data Submittal Template**

Major River Basin	Stream Name	Station Number	DEQ Station ID	Station Location Description	County	Latitude Degrees	Latitude Minutes	Latitude Seconds	Longitude Degrees	Longitude Minutes	Longitude Seconds
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Latitude Decimal Degrees	Longitude Decimal Degrees	Collection Date (mm/dd/yy)	Collection Time (24hr - xx:xx)	Water Temperature Value (Units)	pH Value (Standard Units)	Dissolved Oxygen Value (Units)	Comments	Additional Parameter (name) Value	Etc.
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## **Appendix 5**

# **Boilerplate Memorandum of Agreement**

**Memorandum of Agreement to Support the Virginia Citizen Water Quality  
Monitoring Program Between the Virginia Department Of Environmental  
Quality and  
ORGANIZATION NAME**

**A. Purpose**

The Virginia Department of Environmental Quality (DEQ) and ORGANIZATION NAME are dedicated to supporting the Virginia Citizen Water Quality Monitoring Program for the purpose of collecting useful water quality information and encouraging environmental stewardship. We recognize that cooperative efforts enhance Virginia's ability to monitor, assess, protect and restore the Commonwealth's water quality while also strengthening citizen commitments to water quality issues. We have entered into this agreement with the understanding that combined efforts will produce greater and more consistent benefits by more effectively utilizing the resources of the DEQ and ORGANIZATION NAME and eliminating duplication of effort.

**B. Background**

In the 2002 General Assembly Session, legislation was introduced and passed (§62.1-44.19:11 of the Code of Virginia) which gave DEQ the authority to provide grants to support citizen water quality monitoring groups if (i) the monitoring is done pursuant to a memorandum of agreement with the Department, (ii) the project or activity is consistent with the Department of Environmental Quality's water quality monitoring program, (iii) the monitoring is conducted in a manner consistent with the Virginia Citizens Monitoring Methods Manual, and (iv) the location of the water quality monitoring activity is part of the water quality control plan required under the Code of Virginia. This legislation also prohibits the use of citizen data as evidence in any enforcement actions.

[Customize the paragraph below for the organization]

ORGANIZATION NAME has been committed to protecting the natural resources of STREAM NAME OR WATERSHED NAME. ORGANIZATION NAME has collected water quality data over the past NUMBER years. In keeping with this commitment to protecting the natural resources of the STREAM NAME OR WATERSHED NAME, ORGANIZATION NAME is entering into this agreement with DEQ.

**C. Signatory Responsibilities**

**Virginia Department of Environmental Quality**

Since a goal of the Virginia Citizen Water Quality Monitoring Program is to produce citizen water quality data that can be used by DEQ for water quality assessments, DEQ will provide technical expertise to assist ORGANIZATION NAME in meeting this goal. DEQ will continue to provide technical expertise and general information about monitoring water quality including monitoring protocols, planning water quality monitoring programs, existing agency monitoring locations, site selection, data management, and quality assurance and quality control measures. DEQ will maintain a Virginia citizen monitoring methods manual. DEQ will promote the use of

citizen water quality data to meet the Commonwealth's water quality data needs and will assist in identifying appropriate uses for citizen data. DEQ will continue to assist in identifying new opportunities for citizen stewardship efforts. As part of DEQ's statewide responsibilities, DEQ will provide technical expertise and general information on matters concerning point source pollution and Total Maximum Daily Load development.

ORGANIZATION NAME [Customize the paragraph below for the organization]

ORGANIZATION NAME will adhere to the Quality Assurance Project Plan developed by ORGANIZATION NAME and provide citizen water quality data for the watershed that can be used by DEQ for water quality assessments. ORGANIZATION NAME will be responsible for ensuring that their citizen monitors are properly trained, providing quality assurance oversight for participating volunteers, recruiting volunteers as necessary, and identifying new opportunities for citizen stewardship activities. ORGANIZATION NAME will use the water quality data collected for educational purposes and to assist with local land use decisions

**D. Monitoring Objectives** [Customize the paragraph below for the organization]

We recognize that cooperative efforts enhance Virginia's ability to monitor, assess, protect and restore the Commonwealth's water resources. To reduce duplication of efforts and to produce data that will be useful for water quality assessments, ORGANIZATION NAME will collect data that is consistent with DEQ's water quality monitoring programs. We recognize the need to coordinate water quality monitoring efforts in a collaborative effort to increase the quality and efficiency

**E. Quality Assurance Project Plans** [Customize the paragraph below for the organization]

The protocols used by ORGANIZATION NAME will be consistent with a revised Virginia citizen monitoring methods manual. ORGANIZATION NAME will select protocols appropriate for the goals of the program with DEQ's assistance. A Quality Assurance Project Plan, developed by ORGANIZATION NAME, documenting the procedures that ORGANIZATION NAME will use for water quality monitoring will be submitted by the end of the first year of this agreement for approval by DEQ.

**F. Monitoring Locations** [Customize the paragraph below for the organization]

We agree to share monitoring locations in an effort to reduce duplication of efforts and produce data that will be useful for water quality assessments. ORGANIZATION NAME should also consult the Virginia Water Monitoring Council website at <http://www.vwnc.vt.edu/vwmc> for information on other water quality monitoring activities in the watershed.

### **G. Period of Performance**

The Virginia Citizen Water Quality Monitoring Program continues to evolve to meet the needs of the Commonwealth. This document reflects the signatories' plan for cooperative efforts and should not be construed as a binding contract. Either party may leave this cooperative program at any time and for any reason. Performance of this agreement will continue for a period of 24 months, at which time the agreement will be reviewed and renewed, upon mutual agreement of the signatories.

Nothing in this agreement prohibits DEQ, or ORGANIZATION NAME from entering into similar agreements with other organizations. Nothing in this agreement prohibits DEQ or ORGANIZATION NAME from implementing other programs for which they are responsible. Additional parties may be added to this agreement upon the mutual consent of the signatories.

### **H. Grant Agreement**

If ORGANIZATION NAME receives any sources of funding through the Commonwealth, a separate grant agreement with a workplan containing deliverables will be executed.

We, hereby, agree to the conditions described herein:

**ORGANIZATION NAME**

By:

\_\_\_\_\_

Title:

\_\_\_\_\_

Date:

\_\_\_\_\_

**Virginia Department of Environmental  
Quality**

By:

\_\_\_\_\_

Title: Robert G. Burnley, Director, Virginia  
Department of Environmental Quality

Date:

\_\_\_\_\_

## **Appendix 6**

### **Virginia Citizens for Water Quality List Serve**

## Virginia Citizens for Water Quality List Serve

To sign up, send a message to  
maiser@lsv.dcr.state.va.us

Then in the body of the text put the following message AND NOTHING ELSE!  
SUBSCRIBE vacwqlist

Use the CWQ list serve to share water quality stories, information about events, post questions, etc. Details about the list serve and the guidelines for the list serve are below my signature block.

If you have questions, comments, problems, please let me know!

### Introduction to the Citizens for Water Quality (CWQ) List-Serve

The CWQ eMailing List is managed by the web team at the Virginia Department of Conservation and Recreation (DCR) to facilitate information exchange, communication, and group discussion related to water quality issues in Virginia.

CWQ and DCR endorse a policy of free access to the CWQ Mailing List and public dissemination of information communicated through the CWQ Mailing List.

People who are interested in information exchanges and discussions and accept the following Guidelines are welcome to use the CWQ Mailing List service.

### How to Join and Leave the CWQ Mailing List

To subscribe to the CWQ List-Serve, send an email message to: <maiser@lsv.dcr.state.va.us>. Please note that the < and > signs should not be included in the E-Mail address or message. These signs are just used to indicate that anything outside the signs should not be included in the address.

The subject of the message doesn't matter, but in the message itself should be the instruction SUBSCRIBE vacwqlist

Anything else in the message will be ignored.

By initiating subscription to the CWQ Mailing List it is understood that the subscriber knows the functioning of the CWQ Mailing List as described here. The subscriber confirms that he or she has read the Guidelines, agrees with it, and will abide by its content.

To remove your address from the CWQ List-Serve, please send an E-Mail message to the same address as above, with the instruction UNSUBSCRIBE vacwqlist in the body of the message.

**PLEASE DO NOT SEND REMOVAL MESSAGES TO THE CWQ MAILING LIST!** The list server software will ignore those requests.

It is possible to specify that messages be sent to the user in a digest format (that is, all of the messages for a day are gathered together and sent at once to the user, rather than each message as it comes in), as well as other options. To get a full list of list server commands, send a message to the address above, with the instruction HELP as the body of the message. A help file will be returned describing all mailing list options.

## **Posting Messages**

To post an email message on the CWQ List-Serve after you have signed up, send your message to the following address: <vacwqlist@lsv.dcr.state.va.us>. Messages posted to the CWQ List-Serve will be forwarded to all currently registered subscribers of the CWQ List-Serve. Messages sent to the CWQ List-Serve are stored and included in the CWQ List-Serve Archives, which will be available soon.

## **Replying to Messages**

To reply to a message posted on the CWQ List-Serve use the Reply to: or Answer feature of your email program. Since some mail programs may not use the reply-to address included in a mail message, make sure that the reply is addressed to vacwqlist@lsv.dcr.state.va.us. Your reply message will be distributed to all CWQ List-Serve subscribers. Please note that a reply message intended only for the originator of the message may also be sent to all CWQ List-Serve subscribers.

To avoid public dissemination of such a message and in order to protect the entire CWQ List-Serve subscriber community from irrelevant messages, please do not use the reply function of your e-mail service. Instead, generate a new email message to the intended recipient.

## **Monitoring, Publication, and Storage of Messages**

The CWQ List-Serve aims to provide a freely accessible and open communication forum that facilitates discussion and sharing of experience in the field of water quality issues in Virginia. The CWQ List-Serve therefore adheres to the principle of free speech and stresses individual responsibility for statements communicated through it.

Furthermore, users who repeatedly violate the Protocol are subject to cancellation of their subscription upon appropriate warning by the CWQ List-Serve.

The CWQ List-Serve Archive is meant for public access and reference. The CWQ advises its List-Serve subscribers that even after users delete an email message from their computers or email accounts it may remain in the Archive or other backup facilities and thus is subject to public disclosure. Details about the archive will come at a later point

## **Citizens for Water Quality List-Serve Guidelines**

List serves or electronic mailing lists are one of the most useful means of communication, since they enable their members to instantly transmit or receive information and opinions on matters of common interest. When a message is sent to an electronic mailing list the list server immediately distributes it to all subscribers. Conversely, when replies to that message are emailed; they too, are broadcast to the entire list of subscribers in a matter of minutes or seconds, making this a highly interactive form of communication.

The following suggested guidelines are intended to make the electronic mailing lists valuable and productive for all subscribers.

1. Keep a Copy of the Welcome Letter When you successfully sign-up with the CWQ List-

Serve, you will receive a welcome message. This letter will contain tips for sending your mail as well as how to unsubscribe from that mailing list. You should store this message either on your computer or print a hard copy.

2. **Following Threads of Discussions** By signing up with the CWQ List-Serve, you are not obligated to respond to all messages, or to any message. Pick and choose the topics that interest you. Look at the subject line of the incoming messages to see which thread of discussion is being addressed in that message.

3. **Help When You Can** The purpose of the CWQ List-Serve is to share information. Help individuals in a query whenever you can, because someday you may want help locating information. Sometimes it is better to respond to just an individual rather than sending your message to the entire CWQ List-Serve group.

4. **Unsubscribe If You'll Be Gone** If you plan on being gone for more than a week and will be unable to check your e-mail, you should unsubscribe from the list then you can resubscribe when you return.

5. **Use a Meaningful Subject Line** When people receive mail from a listserv, one of the first pieces of information they look at is the subject line. Most people will keep the same subject line when they respond to a particular thread of discussion. Some people will delete unread messages simply because the subject line announces a topic that they are not interested in. This saves time for many people.

6. **Sending Attachments** Never send attachments with e-mail messages to individuals or to the CWQ List-Serve without prior permission from the recipient.

7. **Cross Posting** If you are posting the same message to several listserves, at the beginning of your messages state, "This message has been cross posted to (names of other listserves)."

8. **Brevity is important.** Please keep your messages as short and to the point as is consistent with conveying the substance of your thoughts.

9. **Identify yourself.** Please sign your message with your full name and Citizens for Water Quality affiliation. Among other things, this gives your colleagues the opportunity to consult directly with you on questions or issues that may have come up in the discussion.

10. **Be careful with replies.** It is important to remember that all messages and replies posted to the list are sent to the entire list. Consequently, if you wish to transmit something of a more personal or private nature, please send it directly to the recipient rather than through the electronic mailing list. When possible, avoid replies that include prior correspondence since long messages tend to slow the process. Please do not use auto-reply. Electronic mailing lists often include a large number of individuals, which makes auto-replies undesirable. If you will be gone for a period of time, please unsubscribe before you leave and subscribe when you return.

11. **Do not challenge or attack others.** The discussions are meant to stimulate conversation not to create contention. Let others have their say, just as you may. All defamatory, abusive, profane, threatening, offensive, or illegal materials are strictly prohibited. Do not post anything in a discussion group message that you would not want the world to see or that you would not want anyone to know came from you.

12. **Responding to Messages** Only send a message to the entire list when it contains information that everyone can benefit from. Send messages such as "thanks for the information" or "me too" to individuals--not to the entire list. Do this by using your e-mail application's forwarding option and typing in or cutting and pasting in the e-mail address of the individual to whom you want to respond.

13. You could consider prefacing your message with headings like: No Response required; For

Information Only; Urgent Response Required etc.

14. Do not publish jokes circulating in other email lists however funny you think they are. This does not exclude the use of humor!

15. You can ask to be removed temporarily or permanently at any time.

16. Send a message of greeting to the list! This will help give you the hang of it, and prepare you for the day that you want to urgently communicate on a real matter.

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# **Appendix 7**

## **Resources**

## Resources

### **General Citizen Water Quality Monitoring Resources**

Campbell, G. and S. Wildberger. 1992. *The Monitor's Handbook*. LaMotte Company, Chestertown, Md. 71 pp.

Center for Marine Conservation & U. S. EPA. *Volunteer Estuary Monitoring: A Methods Manual*, Second Edition. Web site: <http://www.epa.gov/owow/monitoring/volunteer/>

Hach. 1997. *Hach Water Analysis Handbook*. 3<sup>rd</sup> ed. Hach Company, Loveland CO.

Miller, J.K. 1995. *Program Organizing Guide*. River Watch Program of River Network. Montpelier, VT.

Mitchell, M., and W. Stapp. 1999 *Field Manual for Water Quality Monitoring*. 12<sup>th</sup> ed. Kendall/Hunt. Available from GREEN, c/o Earth Force, Inc., 1908 Mount Vernon Ave., Alexandria, VA. Web site: <http://www.earthforce.org/green/>

U. S. Environmental Protection Agency (USEPA). 1990. *Volunteer Water Monitoring: A Guide For State Managers*. EPA 440/4-90-010. August. Office of Water, Washington, DC. 78 pp. Web site: <http://www.epa.gov/owow/monitoring/volunteer/>

U. S. Environmental Protection Agency (USEPA), 1991. *Volunteer Lake Monitoring: A Methods Manual*. EPA 4400/4-91-002. Office of Water, Washington, DC. 121 pp. Web site: <http://www.epa.gov/owow/monitoring/volunteer/>

U. S. Environmental Protection Agency (USEPA). 1997. *Volunteer Stream Monitoring: A Methods Manual*. EPA841-B-97-003. November. Office of Water, Washington, DC. 211 pp. Web site: <http://www.epa.gov/owow/monitoring/volunteer/>

### **Web Sites**

Chesapeake Bay Program: <http://www.chesapeakebay.net/>

Citizens for Water Quality: <http://www.vasos.org/cwq.htm>

National Oceanic & Atmospheric Administration (NOAA)  
National Sea Grant Program: <http://www.nsgo.seagrant.org/index.html>  
Volunteering for the Coast: <http://volunteer.nos.noaa.gov/>

U. S. Environmental Protection Agency (EPA)  
Surf Your Watershed: <http://www.epa.gov/surf>  
Volunteer Monitoring <http://www.epa.gov/owow/monitoring/volunteer/>  
Watershed Information Network <http://www.epa.gov/win>

Virginia Department of Conservation and Recreation (DCR)  
Adopt-A-Stream: <http://www.dcr.state.va.us/sw/adopt.htm>

Virginia Department of Virginia Department of Environmental Quality (DEQ)  
Citizen Monitoring: <http://www.deq.state.va.us/cmonitor/>  
DEQ Monitoring Data: <https://www.deq.state.va.us/webapp/wqm.homepage>

Virginia Water Monitoring Council: <http://www.vwrrc.vt.edu/vwmc/>

### **Newsletters**

*Coastlines* - National Estuary Program Newsletter  
Available online at <http://www.epa.gov/nep/coastlines>. Subscriptions are free. To subscribe, contact [coastlines@umbsky.cc.umb.edu](mailto:coastlines@umbsky.cc.umb.edu).

*The Volunteer Monitor* - National Newsletter of Volunteer Water Quality Monitoring  
Available online at [http://www.epa.gov/owow/monitoring/volunteer/vm\\_index.html](http://www.epa.gov/owow/monitoring/volunteer/vm_index.html).  
Subscriptions are free. To subscribe, contact [skvigil@yahoo.com](mailto:skvigil@yahoo.com)

### **List Serves**

Citizens for Water Quality List Serve (Virginia Citizen Monitoring List Serve): Please see Appendix 6 for instructions and guidelines for this list serve.

EPA Volunteer Monitoring List Serve (National Citizen Monitoring List Serve):  
To subscribe or unsubscribe, send an email to [listserver@unixmail.rtpnc.epa.gov](mailto:listserver@unixmail.rtpnc.epa.gov). Leave the subject line blank. In the message type:  
Subscribe volmonitor lastname firstname or unsubscribe volmonitor lastname firstname  
To post a message, address your email to [volmonitor@unixmail.rtpnc.epa.gov](mailto:volmonitor@unixmail.rtpnc.epa.gov)

## **Chapter 2: Quality Assurance Project Plans and Approved Methods**

American Public Health Association (APHA), American Water Works Association, and Water Environment Federation. 1998. *Standard Methods for the Examination of Water and Wastewater*. 20<sup>th</sup> ed. L. S. Clesceri, A. E. Greenberg, A.D. Eaton (eds). Washington, DC.

Mattson, M. 1992. "The Basics of Quality Control." *The Volunteer Monitor* 4(2): 6-8.

U. S. Environmental Protection Agency (USEPA). 1996. *The Volunteer Monitor's Guide to Quality Assurance Project Plans*. EPA 841-B-96-003. September. Web site:  
<http://www.epa.gov/OWOW/monitoring/volunteer/qappcovr.htm>

## **Chapter 4: Dissolved Oxygen**

Green, L. 1997. "Common Questions About DO Testing." *The Volunteer Monitor* 9(1).

Green, L. 1998. "Let Us Go Down to the Sea-How Monitoring Changes from River to Estuary." *The Volunteer Monitor* 10(2): 1-3.

## **Chapter 6: Nutrients**

Dates, G. 1994. "Monitoring for Phosphorus or How Come They Don't Tell You This Stuff in the Manual?" *The Volunteer Monitor* 6(1).

Katznelson, R. 1997. "Nutrient Test Kits: What Can We Expect?" *The Volunteer Monitor* 9(1).

## **Chapter 7: Benthic Macroinvertebrates**

Engel, Sarah R. and J. Reese Voshell, Jr. 2002. "Volunteer Biological Monitoring: Can It Accurately Assess the Ecological Condition of Streams?" *American Entomologist* 48 (3): 164-177. Web site: <http://www.vasos.org/ValidationStudy.htm>

U. S. Environmental Protection Agency (USEPA). 1999. *Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers; Periphyton, Benthic Macroinvertebrates and Fish*, second edition, EPA Publication 841-B-99-002. Web site: <http://www.epa.gov/owow/monitoring/rbp>

## **Web Sites**

Virginia Save Our Streams Program: <http://www.sosva.com/>

## **Chapter 8: Bacteria**

Ely, E. 1998. "Bacteria Testing Part 1: Methods Primer." *The Volunteer Monitor* 10(2):8-9

Ely, E. 1998. "Bacteria Testing Part 2: What Methods Do Volunteer Group Use?" *The Volunteer Monitor* 10(2): 10-13.

Ely, E. 1997 "Interpreting Fecal Coliform Data: Tracking Down the Right Sources." *The Volunteer Monitor* 9(2): 18-20

Miceli, G. 1998. "Bacteria Testing Q & A." *The Volunteer Monitor* 10(2): 13-15

## **Chapter 10: Submerged Aquatic Vegetation (SAV)**

U. S. Environmental Protection Agency (USEPA). 2000. *Chesapeake Bay Submerged Aquatic Vegetation Water Quality and Habitat-Based Requirements and Restoration Targets: A Second Technical Synthesis*. August.

Bergstrom, P. 1998. "SAV Hunter's Guide (for Chesapeake Bay)." *The Volunteer Monitor* 10(2): 17.

Hurley, L. M. 1992. *Field Guide to the Submerged Aquatic Vegetation of the Chesapeake Bay*. U. S. Fish and Wildlife Service Chesapeake Bay Estuary Program. Annapolis, MD. 52PP. (NOTE: Out of print).

Meyers, D. 1999. "Volunteers Add 'Missing Piece': Monitoring Restoration." *The Volunteer Monitor* 11(1): 10-11.

Reshetiloff, K. 1998 "SAV Hunt: Citizens Keep Track of Bay Grasses." *The Volunteer Monitor* 10(2): 16

### **Web Sites**

Alliance for the Chesapeake Bay: <http://www.acb-online.org/projects.cfm>

Chesapeake Bay Foundation: <http://www.savethebay.cbf.org>

Chesapeake Bay Program: <http://www.chesapeakebay.net/baygras.htm>

U. S. Fish and Wildlife Service Chesapeake Bay Field Office:  
<http://www.fws.gov/r5cbfo/CBSAV.HTM>

Virginia Institute of Marine Science: <http://www.vims.edu/bio/sav/index.html>

## **Chapter 15: Stream Flow**

Rantz, S.E., and others, 1982, *Measurement and Computation of Streamflow: Volume 2. Computation of Discharge*. U. S. Geological Survey Water-Supply Paper. 2175.

### **Web Sites**

U. S. Geological Survey (USGS): <http://www-va.usgs.gov>

## **Chapter 16: Stream Walks**

U. S. Department of Agriculture. 1998. *National Water and Climate Center Technical Note 99-1: Stream Visual Assessment Protocol*. December.

U. S. Environmental Protection Agency (USEPA). 1997. *Volunteer Stream Monitoring: A Methods Manual*. EPA841-B-97-003. November. Office of Water, Washington, DC. 211 pp. Web site <http://www.epa.gov/owow/monitoring/volunteer/>

## **Chapter 17: Riparian Forests**

Austin, Samuel H. 1999. *Riparian Forest Handbook 1*, Virginia Department of Forestry, December.

## **Appendix 8**

### **Equipment Suppliers**

## Equipment Suppliers

This is a partial list of common equipment suppliers from which a volunteer monitoring program may obtain equipment for water quality monitoring. This list is intended to assist programs in locating equipment and does not imply endorsement by the Virginia Citizen Water Quality Monitoring Program or any of its partners.

### **Ben Meadows Company**

<http://www.benmeadows.com>

Phone: 800-241-6401

Waders, field water test equipment, nets.

### **Carolina Biological Supply Company**

<http://www.carolina.com>

Phone: 800-334-5551

Forceps, reagents, educational materials.

### **Cole Parmer Instruments, Inc.**

<http://www.coleparmer.com>

Phone: 800-323-4340

Lab equipment, field water test equipment.

### **Earth Force**

<http://www.earthforce.org>

E-mail: [green@earthforce.org](mailto:green@earthforce.org)

Phone: 703-299-9485

Low-cost kits for schools.

### **Fisher Scientific Company**

<http://www.fishersci.com>

Phone: 800-766-7000

Lab equipment, sample bottles, reagents, water test equipment, Whirl-paks.

### **Forestry Suppliers, Inc.**

<http://www.forestry-suppliers.com>

Phone: 800-647-5368

Secchi disks, transparency tubes, equipment.

### **Hach Equipment Company**

<http://www.hach.com>

Phone: 800-227-4224

Field and lab equipment, reagents.

### **Hydrolab Corporation**

<http://www.hydrolab.com>

Phone: 800-949-3766

Multi-parameter meters for water monitoring.

### **Idexx Laboratories**

<http://www.idexx.com/water>

Phone: 800-321-0207

Colilert method for bacterial monitoring.

### **LaMotte**

<http://www.lamotte.com>

Phone: 800-344-3100

Field and lab water testing equipment, Secchi disks, armored thermometers.

### **Micrology Laboratories**

<http://micrologylabs.com>

Phone: 888-EASYGEL

Coliscan Easygel method for bacterial monitoring.

### **Nichols Net and Twine, Inc.**

Phone: 618-797-0222; 800-878-6387

Nets of all kinds (dip, kick, macroinvertebrates), seines, custom nets.

### **Water Monitoring Equipment & Supply**

<http://www.watermonitoringequip.com>

E-mail: [info@watermonitoringequip.com](mailto:info@watermonitoringequip.com)

Phone: 207-276-5746

Transparency tubes, monitoring equipment.

### **YSI Incorporated**

<http://www.ysi.com>

Phone: 937-767-7241

Meters for water quality monitoring.

## **Appendix 9**

# **Monitoring Levels of Citizen Water Quality Data in Virginia**

## Monitoring Levels of Citizen Water Quality Data in Virginia

In Virginia, three levels of data quality have been developed by the Department of Environmental Quality (DEQ) based upon the use of citizen water quality data by the agency and other data users. Citizen-collected data may be used to educate the community, to assist local governments in land use planning, to supplement data for university and professional studies, and to assist local soil and water conservation districts in prioritizing watershed work for best management practices.

<b><u>Level</u></b>	<b><u>Appropriate Data Uses (refer to Appendix 2)</u></b>	<b><u>QA/QC Protocols</u></b>
I	<ul style="list-style-type: none"> <li>• Education</li> <li>• Baseline</li> <li>• Red Flags</li> <li>• Local Land Use Decisions</li> <li>• Special Studies</li> </ul>	<ul style="list-style-type: none"> <li>• No Quality Assurance Project Plan (QAPP) or SOP required by DEQ.</li> <li>• Uniform methodology recommended.</li> <li>• QAPP, SOPs and/or lab methods do not meet DEQ quality assurance/quality control requirements.</li> <li>• There is no Virginia Water Quality Standard for parameter the method measures.</li> </ul>
II	<ul style="list-style-type: none"> <li>• Assessment Information</li> <li>• Education</li> <li>• Baseline</li> <li>• Red Flags</li> <li>• Local Land Use Decisions</li> <li>• Special Studies</li> </ul>	<ul style="list-style-type: none"> <li>• DEQ-approved Quality Assurance Project Plan and SOPs using DEQ-approved methods.</li> <li>• At this level, there may be deviation from an approved method if it can be demonstrated that the method collects data of similar quality to an approved method.</li> <li>• Field and/or laboratory audit required.</li> </ul>
III	<ul style="list-style-type: none"> <li>• Impairment, or 303(d), listings</li> <li>• Assessment Information</li> <li>• Education</li> <li>• Baseline</li> <li>• Red Flags</li> <li>• Local Land Use Decisions</li> <li>• Special Studies</li> </ul>	<ul style="list-style-type: none"> <li>• DEQ-approved Quality Assurance Project Plan and SOPs with no deviation from approved methods (i.e., a Standard Method (APHA, 1998) or method approved by the U.S. Environmental Protection Agency).</li> <li>• Field and/or laboratory audit required.</li> </ul>

# **Appendix 10**

## **Monitoring Plan Worksheets**

## Monitoring Plan Worksheets

(Chapter 1 will guide you with completing these worksheets)

Project Name: \_\_\_\_\_

Organization Name: \_\_\_\_\_

Contact Person for Project: \_\_\_\_\_

Phone Number for Contact: \_\_\_\_\_

Email Address for Contact: \_\_\_\_\_

Mailing Address for Contact: \_\_\_\_\_

Date Monitoring Plan Completed: \_\_\_\_\_

### Step 1: Problem Definition/Background

1. What waterbody(ies) do you want to monitor? \_\_\_\_\_

2. What monitoring/studies have been conducted in your waterbody of interest? \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

3. Have you consulted the following sources to determine if monitoring data has been collected:

- |  |                          |
|--|--------------------------|
| a. DEQ Water Quality Monitoring Database at<br><a href="http://www.deq.state.va.us/water/monitoring.html">http://www.deq.state.va.us/water/monitoring.html</a> | <input type="checkbox"/> |
| b. VWMC online database at<br><a href="http://www.vwrrc.vt.edu/vwmc/Survey.asp">http://www.vwrrc.vt.edu/vwmc/Survey.asp</a>                                    | <input type="checkbox"/> |
| c. USGS  | <input type="checkbox"/> |
| Local governments  | <input type="checkbox"/> |
| Local soil and water conservation district   | <input type="checkbox"/> |
| College or universities  | <input type="checkbox"/> |
| Others? _____  | <input type="checkbox"/> |

Problem statement/issues affecting your watershed? \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

## Step 2: Why Are You Monitoring?

A. Overall goals: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

B. Questions and information needed to address issues

<b><u>Questions/Issues to Address</u></b>	<b><u>Information Needed</u></b>

**Step 3: Intended Uses and Users of Data**

List data users and intended use of data. Consult with data users to determine the quality of data they need. For example, if data will be used for screening purposes only, you may not need to use approved methods or follow rigorous quality assurance/quality control checks on the data.

<u>Data User</u>	<u>Data Use</u>	<u>Level of Data Quality Needed</u>

**Step 4: Where Will You Monitor?**

- A. Are all sites in safe locations on public property or where landowner permission has been obtained? \_\_\_\_\_
- B. Are all sites representative of the stream (in the main flow of the stream away from discharge pipes)? \_\_\_\_\_
- C. At what depth will samples be collected? \_\_\_\_\_



**Steps 5 & 6: What Parameters/Conditions Will You Monitor?**

Sampling Methods and Analytical Methods Requirements

<b><u>Parameter</u></b>	<b><u>Field or Lab Analysis</u></b>	<b><u>Sampling Method (specify lab analysis method number or manufacturer and model # of test kit, meter, or other instrument)</u></b>	<b><u>Why Do You Want to Monitor this Parameter?</u></b>
Bacteria - <i>E. coli</i>			
Bacteria – Fecal Coliform			
Benthic Macroinvertebrates			
Chlorophyll <i>a</i>			
Conductivity			
Dissolved Oxygen			
Flow			
Nitrogen (Identify species)			
pH			
Phosphorus (Identify species)			
Salinity			
Total Solids (specify form)			
Turbidity/ Transparency			
Water Temperature			
Other			
Other			
Other			
Other			
Other			

## Step 8: When Will You Sample?

[illegible]

## Step 9: Data Management and Reports

- A. What will happen to data sheets once they are completed? \_\_\_\_\_  
\_\_\_\_\_
- B. What software program will be used? \_\_\_\_\_  
\_\_\_\_\_
- C. Who will enter the data? \_\_\_\_\_
- D. Who will verify the accuracy of data entry? \_\_\_\_\_
- E. How will data be analyzed? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
- F. How will data be communicated to others? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

## Step 10: Quality Assurance/Quality Control

- A. Training Requirements/Certification
1. Who will train volunteers? \_\_\_\_\_
  2. Describe initial training requirements. \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
  3. Describe refresher training requirements. \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
- B. Is a QAPP needed for intended use of data? \_\_\_\_\_

If so, these worksheets can be expanded into a formal QAPP (Chapter 2 and Appendix 14 )

## **Appendix 11**

**Technical Resource: Excerpt from  
EPA *Guidance Specifying  
Management Measures for Sources  
of Nonpoint Pollution in Coastal  
Waters***

In 1990, Congress enacted the Coastal Zone Act Reauthorization Amendments and included a new section titled ‘Protecting coastal waters (Section 6217)’. The program is jointly administered by the National Oceanic & Atmospheric Administration (NOAA) and the U.S. Environmental Protection Agency (EPA). The purpose of the program is to develop and implement management measures for nonpoint sources of pollution to restore and protect coastal waters. A key element of the program is to work in coordination with other federal, state, and local entities. Each state program is required to develop a program under this section that will ‘provide for the implementation, at a minimum, of management measures in conformity with the guidance published under subsection (g), to protect coastal waters.’

This appendix is intended to provide additional technical resource information to organizations and individuals that conduct water quality monitoring activities. The information has been excerpted from guidance developed by national work groups and released in 1993 by EPA. The full guidance document can be found at <http://www.epa.gov/owow/nps/MMGI/>. EPA has recently released updated individual chapters as ‘national’ management measures. The updates can be found at <http://www.epa.gov/owow/nps/pubs.html>.

## **II. Techniques for Assessing Water Quality and for Estimating Pollution Loads**

Water quality monitoring is the most direct and defensible tool available to evaluate water quality and its response to management and other factors (Coffey and Smolen, 1990). This section describes monitoring methods that can be used to measure changes in pollutant loads and water quality. Due to the wide range of monitoring needs and environmental conditions throughout the coastal zone it is not possible to specify detailed monitoring plans that apply to all areas within the zone. The information in this section is intended merely to guide the development of monitoring efforts at the State and local levels.

This section begins with a brief discussion of the scope and nature of nonpoint source problems, followed by a discussion of monitoring objectives as they relate to section 6217. A lengthy discussion of monitoring approaches is next, with a focus on understanding the watershed to be studied, appropriate experimental designs, sample size and frequency, site locations, parameter selection, sampling methods, and quality assurance and quality control. The intent of this discussion is to provide the reader with basic information essential to the development of effective, tailored monitoring programs that will provide the necessary data for use in statistical tests that are appropriate for evaluating the success of management measures in reducing pollutant loads and improving water quality.

After a brief discussion of data needs, an overview of statistical considerations is presented. Variability and uncertainty are described first, followed by a lengthy overview of sampling and sampling designs. This discussion is at a greater level of detail than others in the section to emphasize the importance of adequate sampling within the framework of a sound experimental design. Hypothesis testing is described next, including some examples of hypotheses that may be appropriate for section 6217 monitoring efforts. An overview of data analysis techniques is given at the end of the section.

## **A. Nature and Scope of Nonpoint Source Problems**

Nonpoint sources may generate both conventional and toxic pollutants, just as point sources do. Although nonpoint sources may contribute many of the same kinds of pollutants, these pollutants are generated in different volumes, combinations, and concentrations. Pollutants from nonpoint sources are mobilized primarily during storm events or snowmelt, but baseflow contributions can be the major source of nonpoint source contaminants in some systems. Thus, knowledge of the hydrology of a system is critical to the design of successful monitoring programs.

Nonpoint source problems are not just reflected in the chemistry of a water resource. Instead, nonpoint source problems are often more acutely manifested in the biology and habitat of the aquatic system. Such impacts include the destruction of spawning areas, impairments to the habitat for shellfish, changes to aquatic community structure, and fish mortality. Thus, any given nonpoint source monitoring program may have to include a combination of chemical, physical, and biological components to be effective.

## **B. Monitoring Objectives**

Monitoring is usually performed in support of larger efforts such as nonpoint source pollution control programs within coastal watersheds. As such, monitoring objectives are generally established in a way that contributes toward achieving the broader program objectives. For example, program objectives may include restoring an impaired use or protecting or improving the ecological condition of a water resource. Supporting monitoring objectives, then, might include assessing trends in use support or in key biological parameters.

The following discussion identifies the overall monitoring objectives of section 6217 and gives some examples of specific objectives that may be developed at the State or local level in support of those overall objectives. Clearly, due to the prohibitive expense of monitoring the effectiveness of every management measure applied in the coastal zone, States will need to develop a strategy for using limited monitoring information to address the broad questions regarding the effectiveness of section 6217 implementation. A combination of watershed monitoring to track the cumulative benefits of systems of management measures and demonstrations of selected management measures of key importance in the State may be one way in which the overall section 6217 monitoring objectives can be met within the constraints imposed by limited State monitoring budgets.

### **1. Section 6217 Objectives**

The overall management objective of section 6217 is to develop and implement management measures for nonpoint source pollution to restore and protect coastal waters. The principal monitoring objective under section 6217(g) is to assess over time the success of the management measures in reducing pollution loads and improving water quality. A careful reading of this monitoring objective reveals that there are two sub-objectives: (1) to assess changes in pollution loads over time and (2) to assess changes in water quality over time.

A pollutant load is determined by multiplying the total runoff volume times the average concentration of the pollutant in the runoff. Loads are typically estimated only for chemical and some physical (e.g., total suspended solids) parameters. Water quality, however, is determined on the basis of the chemical, physical, and biological conditions of the water resource. Section

6217(g), therefore, calls for a description of pollutant load estimation techniques for chemical and physical parameters, plus a description of techniques to assess water quality on the basis of chemical, physical, and biological conditions. This section focuses on those needs.

## **2. Formulating Monitoring Objectives**

A monitoring objective should be narrowly and clearly defined to address a specific problem at an appropriate level of detail (Coffey and Smolen, 1990). Ideally, the monitoring objective specifies the primary parameter(s), location of monitoring (and perhaps the timing), the degree of causality or other relationship, and the anticipated result of the management action. The magnitude of the change may also be expressed in the objective. Example monitoring objectives include:

- To determine the change in trends in the total nitrogen concentration in Beautiful Sound due to the implementation of nutrient management on cropland in all tributary watersheds.
- To determine the sediment removal efficiency of an urban detention basin in New City.
- To evaluate the effects of improved marina management on metals loadings from the repair and maintenance areas of Stellar Marina.
- To assess the change in weekly mean total suspended solids concentrations due to forestry harvest activities in Clean River.

## **C. Monitoring Approaches**

### **1. General**

#### **a. Types of Monitoring**

The monitoring program design is the framework for sampling, data analysis, and the interpretation of results (Coffey and Smolen, 1990). MacDonald (1991) identifies seven types of monitoring:

1. Trend monitoring;
2. Baseline monitoring;
3. Implementation monitoring;
4. Effectiveness monitoring;
5. Project monitoring;
6. Validation monitoring; and
7. Compliance monitoring.

Trend, baseline, implementation, effectiveness, and project monitoring all relate to the monitoring objectives of section 6217. These types of monitoring, in fact, are not mutually exclusive. The distinction between effectiveness monitoring and project monitoring, for example, is often simply one of scale, with effectiveness monitoring primarily directed at individual practices and project monitoring directed at entire sets of practices or activities implemented over a larger area. Since one cannot evaluate the effectiveness of a project or

management measure (i.e., achievement of the desired effect) without knowing the status of implementation, implementation monitoring is an essential element of both project and effectiveness monitoring. In addition, a test for trend is typically included in the evaluation of projects and management measures, and baseline monitoring is performed prior to the implementation of pollution controls.

Meals (1991a) discussed five major points to consider in developing a monitoring system that would provide a suitable data base for watershed trend detection: (1) understand the system you want to monitor, (2) design the monitoring system to meet objectives, (3) pay attention to details at the beginning, (4) monitor source activities, and (5) build in feedback loops. These five points apply equally to both load estimation and water quality assessment monitoring efforts.

### **b. Section 6217 Monitoring Needs**

The basic monitoring objective for section 6217 is to *assess over time the success of the measures in reducing pollution loads and improving water quality*. This objective would seem to indicate a need for establishing cause-effect relationships between management measure implementation and water quality. Although desirable, monitoring to establish such cause-effect relationships is typically beyond the scope of affordable program monitoring activities.

Mosteller and Tukey (1977) identified four criteria that must be met to show cause and effect: association, consistency, responsiveness, and a mechanism.

- **Association** is shown by demonstrating a relationship between two parameters (e.g., a correlation between the extent of management measure implementation and the level of pollutant loading).
- **Consistency** can be confirmed by observation only and implies that the association holds in different populations (e.g., management measures were implemented in several areas and pollutant loading was reduced, depending on the effect of treatment, in each case).
- **Responsiveness** can be confirmed by an experiment and is shown when the dependent variable (e.g., pollutant loading) changes predictably in response to changes in the independent variable (e.g., extent of management measure implementation).
- **Mechanism** is a plausible step-by-step explanation of the statistical relationship. For example, conservation tillage reduced the edge-of-field losses of sediment, thereby removing a known fraction of pollutant source from the stream or lake. The result was decreased suspended sediment concentration in the water column.

Clearly, the cost of monitoring needed to establish cause-effect relationships throughout the coastal zone far exceeds available resources. It may be suitable, however, to document associations between management measure implementation and trends in pollutant loads or water quality and then account for such associations with a general description of the primary mechanisms that are believed to come into play.

### **c. Scale, Local Conditions, and Variability**

There are several approaches that can be taken to assess the effectiveness of measures in reducing loads and improving water quality. There are also several levels of scale that could be selected: individual practices, individual measures, field scale, watershed scale, basin scale, regional scale, etc. With any given monitoring objective, the specific monitoring approach to use at any specific site is a function of the local conditions (e.g., geography, climate, water resource type) and the type of management measures implemented.

The detection and estimation of trends is complicated by problems associated with the characteristics of pollution data (Gilbert, 1987). Physical, chemical, and biological parameters in the receiving water may undergo extreme changes without the influence of human activity. Understanding and monitoring the factors responsible for variability in a local system are essential for detecting the improvements expected from the implementation of management measures.

Simple point estimates taken before and after treatment will not confirm an effect if the natural variability is typically greater than the changes due to treatment (Coffey and Smolen, 1990). Therefore, knowledge of the variability and the distribution of the parameter is important for statistical testing. Greater variability requires a larger change to imply that the observed change is not due solely to random events (Spooner et al., 1987b). Examination of a historical data set can help to identify the magnitude of natural variability and possible sources.

The impact of management actions may not be detectable as a change in a mean value but rather as a change in variability (Coffey and Smolen, 1990). Platts and Nelson (1988) found that a carefully designed study was required to isolate the large natural fluctuations in trout populations to distinguish the effects of land use management. They assumed that normal fluctuation patterns were similar between the control and the treatment area and that treatment-induced effect could be distinguished as a deviation from the historical pattern.

Meals (1991a) calls for the collection and evaluation of existing data as the first step in a monitoring effort, recognizing that additional background data may be needed to identify hot spots or fill information gaps. The results of such initial efforts should include established stage-discharge ratings and an understanding of patterns not associated with the pollution control effort.

## **2. Understanding the System to Be Monitored**

### **a. The Water Resource**

Options for tracking water quality vary with the type of water resource. For example, a monitoring program for ephemeral streams can be different from that for perennial streams or large rivers. Lakes, wetlands, riparian zones, estuaries, and near-shore coastal waters all present different monitoring considerations. Whereas upstream-downstream designs work on rivers and streams, they are generally less effective on natural lakes where linear flow is not so prevalent. Likewise, estuaries present difficulties in monitoring loads because of the shifting flows and changing salinity caused by the tides. A successful monitoring program recognizes the unique features of the water resources involved and is structured to either adapt to those features or avoid them.

**Streams.** Freshwater streams can be classified on the basis of flow attributes as intermittent or perennial streams. Intermittent streams do not flow at all times and serve as conveyance systems for runoff. Perennial streams always flow and usually have significant inputs from ground water or interflow. For intermittent streams, seasonal variability is a very significant factor in determining pollutant loads and water quality. During some periods sampling may be impossible due to no flow. Seasonal flow variability in perennial streams can be caused by seasonal patterns in precipitation or snowmelt, reservoir discharges, or irrigation practices.

For many streams the greatest concentrations of suspended sediment and other pollutants occur during spring runoff or snowmelt periods. Concentrations of both particulate and soluble chemical parameters have been shown to vary throughout the course of a rainfall event in many studies across the Nation. This short-term variability should be considered in developing monitoring programs for flowing (lotic) waterbodies.

Spatial variability is largely lateral for both intermittent and perennial streams. Vertical variability does exist, however, and can be very important in both stream types (e.g., during runoff events, in tidal waters, and in deep, slow-moving streams). Intake depth is often a key factor in stream sampling. For example, slow-moving, larger streams may show considerable water quality variability with depth, particularly for parameters such as suspended solids, dissolved oxygen, and algal productivity. Suspended sediment samples must be taken with an understanding of the vertical distribution of both sediment concentration and flow velocity (Brakensiek et al., 1979). When sampling bed sediment or monitoring biological parameters, it is important to recognize the potential for significant lateral and vertical variation in the toxicity and contaminant levels of bed sediments (USEPA, 1987).

**Lakes.** Lakes can be categorized in several ways, but a useful grouping for monitoring guidance is related to the extent of vertical and lateral mixing of the waterbody. Therefore, lakes are considered to be either mixed or stratified for the purpose of this guidance. Mixed lakes are those lakes in which water quality (as determined by measurement of the parameters and attributes of interest) is homogenous throughout, and stratified lakes are considered to be those lakes which have lateral or vertical water quality differentials in the lake parameters and attributes of interest. Totally mixed lakes, if they exist, are certainly few in number, but it may be useful to perform monitoring in selected homogenous portions of stratified lakes to simplify data interpretation. Similarly, for lakes that exhibit significant seasonal mixing, it may be beneficial to monitor during a time period in which they are mixed. For some monitoring objectives, however, it may be best to monitor during periods of peak stratification.

Temporal variability concerns are similar for mixed and stratified lakes. Seasonal changes are often obvious, but should not be assumed to be similar for all lakes or even the same for different parts of any individual lake. Due to the importance of factors such as precipitation characteristics, climate, lake basin morphology, and hydraulic retention characteristics, seasonal variability should be at least qualitatively assessed before any lake monitoring program is initiated.

Short-term variability is also an inherent characteristic of most still (lentic) waterbodies. Parameters such as pH, dissolved oxygen, and temperature can vary considerably over the course

of a day. Monitoring programs targeted toward biological parameters should be structured to account for this short-term variability. It is often the case that small lakes and reservoirs respond rapidly to runoff events. This factor can be very important in cases where lake water quality will be correlated to land treatment activities or stream water quality.

In stratified lakes spatial variability can be lateral or vertical. The classic stratified lake is one in which there is an epilimnion and a hypolimnion (Wetzel, 1975). Water quality can vary considerably between the two strata, so sampling depth is an important consideration when monitoring vertically stratified lakes.

Lateral variability is probably as common as vertical variability, particularly in lakes and ponds receiving inflow of varying quality. Figure 8-1 illustrates the types of factors that contribute to lateral variability in lake water quality. In reservoir systems, storm plumes can cause significant lateral variability.

Davenport and Kelly (1984) explained the lateral variability in chlorophyll *a* concentrations in an Illinois lake based on water depth and the time period that phytoplankters spend in the photic zone. A horizontal gradient of sediment, nutrient, and chlorophyll *a* concentrations in St. Albans Bay, Vermont, was related to mixing between Lake Champlain and the Bay (Clausen, 1985). It is important to note that there frequently exists significant lateral and vertical variation in the toxicity and contaminant levels of bed sediments (USEPA, 1987).

Despite the distinction made between mixed and stratified lakes, there is considerable gray area between these groups. For example, thermally stratified lakes may be assumed to be mixed during periods of overturn, and laterally stratified lakes can sometimes be treated as if the different lateral segments are sub-lakes. In any case, it is important that the monitoring team knows what parcel of water is being sampled when the program is implemented. It would be inappropriate, for example, to assign the attributes of a surface sample to the hypolimnion of a stratified lake due to the differences in temperature and other parameters between the upper and lower waters.

**Estuaries.** Estuaries can be very complex systems, particularly large ones such as the Chesapeake Bay. Estuaries exhibit temporal and spatial variability just as streams and lakes do. Physically, the major differences between estuaries and fresh waterbodies are related to the mixing of fresh water with salt water and the influence of tides. These factors increase the complexity of spatial and temporal variability within an estuary.

Short-term variability in estuaries is related directly to the tidal cycles, which can have an effect on both the mixing of the fresh and saline waters and the position of the freshwater-saltwater interface (USEPA, 1982a). The same considerations made for lakes regarding short-term variability of parameters such as temperature, dissolved oxygen, and pH should also be made for estuaries.

Temperature profiles such as those found in stratified lakes can also change with season in estuaries. The resulting circulation dynamics must be considered when developing monitoring programs. The effects of season on the quantity of freshwater runoff to an estuary can be profound. In the Chesapeake Bay, for example, salinity is generally lower in the spring and

higher in the fall due to the changes in freshwater runoff from such sources as snowmelt runoff and rainfall (USEPA, 1982a).

Spatial variability in estuaries has both significant vertical and lateral components. The vertical variability is related to both temperature and chemical differentials. In the Chesapeake Bay thermal stratification occurs during the summer, and chemical stratification occurs at all times, but in different areas at different times (USEPA, 1982a). Chemical stratification can be the result of the saltwater wedge flowing into and under the freshwater outflow or the accumulation or channeling of freshwater and saltwater flows to opposite shores of the estuary. The latter situation can be caused by a combination of tributary location, the earth's rotation, and the barometric pressure. In addition, lateral variability in salinity can be caused by different levels of mixing between saltwater and freshwater inputs. As noted for streams and lakes, the lateral and vertical variation in the toxicity and contaminant levels of bed sediments should be considered (EPA, 1987).

**Coastal Waters.** Researchers and government agencies are collectively devoid of significant experience in evaluating the effectiveness of nonpoint source pollution control efforts through the monitoring of near-shore and offshore coastal waters. Our understanding of the factors to consider when performing such monitoring is therefore very limited.

As for other waterbody types, it is important to understand the hydrology, chemistry, and biology of the system in order to develop an effective monitoring program. Of particular importance is the ability to identify discrete populations to sample from. For trend analysis it is essential that the researcher is able to track over time the conditions of a clearly identifiable segment or unit of coastal water. This may be accomplished by monitoring a semi-enclosed near-shore embayment or similar system. Knowledge of salinity and circulation patterns should be useful in identifying such areas.

Secondly, monitoring should be focused on those segments or units of coastal water for which there is a reasonable likelihood that changes in water quality will result from the implementation of management measures. Segment size, circulation patterns, and freshwater inflows should be considered when estimating the chances for such water quality improvements.

Near-shore coastal waters may exhibit salinity gradients similar to those of estuaries due to the mixing of fresh water with salt water. Currents and circulation patterns can create temperature gradients as well. Farther from shore, salinity gradients are less likely, but gradients in temperature may occur. In addition, vertical gradients in temperature and light may be significant. These and other biological, chemical, and physical factors should be considered in the development of monitoring programs for coastal waters.

### **3. Experimental Design**

#### **a. Types of Experimental Designs**

EPA has prescribed monitoring designs for use in watershed projects funded under section 319 of the Clean Water Act (USEPA, 1991b). The objective in promoting these designs is to document changes in water quality that can be related to the implementation of nonpoint source control measures in selected watersheds. The designs recommended by EPA are paired-

watershed designs and upstream-downstream designs. Single downstream station designs are not recommended by EPA for section 319 watershed projects (USEPA, 1991b).

Monitoring before implementation is usually required to detect a trend or show causality (Coffey and Smolen, 1990). Two years of pre-implementation monitoring are typically needed to establish an adequate baseline. Less time may be needed for studies at the management measure or edge-of-field scale, when hydrologic variability is known to be less than that of typical agricultural systems, or when a paired-watershed design is used.

**Paired-Watershed Design.** In the paired-watershed design there is one watershed where the level of implementation (ideally) does not change (the control watershed) and a second watershed where implementation occurs (the study watershed). This design has been shown in agricultural nonpoint source studies to be the most powerful study design for demonstrating the effectiveness of nonpoint source control practice implementation (Spooner et al., 1985). Paired-watershed designs have a long history of application in forest hydrology studies. The paired-watershed design must be implemented properly, however, to generate useful data sets. Some of the considerations to be made in designing and implementing paired-watershed studies are described below.

In selecting watershed pairs, the watersheds should be as similar as possible in size, shape, aspect, slope, elevation, soil type, climate, and vegetative cover (Striffler, 1965). The general procedure for paired-watershed studies is to monitor the watersheds long enough to establish a statistical relationship between them. A correlation should be found between the values of the monitored parameters for the two watersheds. For example, the total nitrogen values in the control watershed should be correlated with the total nitrogen values in the study watershed. A pair of watersheds may be considered sufficiently calibrated when a parameter for the control watershed can be used to predict the corresponding value for the study watershed (or vice versa) within an acceptable margin of error.

It is important to note that the calibration period should cover all or the significant portion of the range of conditions for each of the major water quality determinants in the two watersheds. For example, the full range of hydrologic conditions should be covered (or nearly covered) during the calibration period. This may be problematic in areas where rainfall and snowmelt are highly variable from year to year or in areas subject to extended wet periods or drought. Calibration during a dry year is likely to not be adequate for establishing the relationship between the two watersheds, particularly if subsequent years include both wet and dry periods. Similarly, some agricultural areas of the country use long-term, multiple-crop rotations. The calibration period should cover not only the range of hydrologic conditions but also the range of cropping patterns that can reasonably be expected to have an influence on the measured water quality parameters. This is not to say that the calibration period should take 5 to 10 years, but rather that States should use careful judgment in determining when the calibration period can be safely ended.

After calibration, the study watershed receives implementation of management measures, and monitoring is continued in both watersheds. The effects of the management measures are evaluated by testing for a change in the relationship between the monitored parameters (i.e., a

change in the correlation). If treatment is working, then there should be a greater difference over time between the treated study watershed and the untreated (poorly managed) control watershed. Alternatively, the calibration period could be used to establish statistical relationships between a fully treated watershed (control watershed) and an untreated watershed (study watershed). After calibration under this approach, the study watershed would be treated and monitoring continued. The effects of the management measures would be evaluated, however, by testing for a change in the correlation that would indicate that the two watersheds are more similar than before treatment.

It is important to use small watersheds when performing paired-watershed studies since they are more easily managed and more likely to be uniform (Striffler, 1965). EPA recommends that paired watersheds be no larger than 5,000 acres (USEPA, 1991b).

**Upstream-Downstream Studies.** In the upstream-downstream design, there is one station at a point directly upstream from the area where implementation of management measures will occur and a second station directly downstream from that area. Upstream-downstream designs are generally more useful for documenting the magnitude of a nonpoint source than for documenting the effectiveness of nonpoint source control measures (Spooner et al., 1985), but they have been used successfully for the latter. This design provides for the opportunity to account for covariates (e.g., an upstream pollutant concentration that is correlated with a downstream concentration of same pollutant) in statistical analyses and is therefore the design that EPA recommends in cases where paired watersheds cannot be established (USEPA, 1991b).

Upstream-downstream designs are needed in cases where project areas are not located in headwaters or where upstream activities that are expected to confound the analysis of downstream data occur. For example, the effects of upstream point source discharges, uncontrolled nonpoint source discharges, and upstream flow regulation can be isolated with upstream-downstream designs.

**Inflow-Outflow Design.** Inflow-outflow, or process, designs are very similar to upstream-downstream designs. The major differences are scale and the significance of confounding activities. Process designs are generally applied in studies of individual management measures or practices. For example, sediment loading at the inflow and outflow of a detention basin may be measured to determine the pollutant removal efficiency of the basin. In general, no inputs other than the inflow are present, and the only factor affecting outflow is the management measure. As noted above (see The Management Measures to Be Implemented), process monitoring cannot generally be applied to studies of source-reduction management measures or measures that prevent direct impacts, but it can be applied successfully in the evaluation of delivery-reduction management measures.

#### **b. Scale**

**Management Measure.** Monitoring the inflow and outflow of a specific management measure should be the most sensitive scale since the effects of uncontrollable discharges and uncertainties in treatment mechanisms are minimized.

**Edge of Field.** Monitoring pollutant load from a single-field watershed should be the next most sensitive scale since the direct effects of implementation can be detected without pollutant trapping in a field border or stream channel (Coffey and Smolen, 1990).

**Sub-watershed.** Monitoring a sub-watershed can be useful to monitor the aggregate effect of implementation on a group of fields or smaller areas by taking samples close to the treatment (Coffey and Smolen, 1990). Sub-watershed monitoring networks measure the aggregate effects of treatment and nontreatment runoff as it enters an upgradient tributary or the receiving waterbody. Sub-watershed monitoring can also be used for targeting critical areas.

**Watershed.** Monitoring at the watershed scale is appropriate for assessing total project area pollutant load using a single station (Coffey and Smolen, 1990). Depending on station arrangement, both sub-watershed and watershed outlet studies are very useful for water and pollutant budget determinations. Monitoring at the watershed outlet is the least sensitive of the spatial scales for detecting treatment effect. Sensitivity of the monitoring program decreases with increased basin size and decreased treatment extent or both (Coffey and Smolen, 1990).

### c. Reference Systems and Standards

EPA's rapid bioassessment protocols advocate an integrated assessment, comparing habitat and biological measures with empirically defined reference conditions (Plafkin et al., 1989). Reference conditions are established through systematic monitoring of actual sites that represent the natural range of variation in "least disturbed" water chemistry, habitat, and biological condition. Reference sites can be used in monitoring programs to establish reasonable expectations for biological, chemistry, and habitat conditions. An example application of this concept is the paired-watershed design (Coffey and Smolen, 1990).

EPA's ecoregional framework can be used to establish a logical basis for characterizing ranges of ecosystem conditions or quality that are realistically attainable (Omernik and Gallant, 1986). *Ecoregions* are defined by EPA to be regions of relative homogeneity in ecological systems or in relationships between organisms and their environments. Hughes et al. (1986) have used a relatively small number of minimally impacted regional reference sites to assess feasible but protective biological goals for an entire region.

Water quality standards can be used to identify criteria that serve as reference values for biological, chemical, or habitat parameters, depending on the content of the standard. The frequency distribution of observation values can be tracked against either a water quality standard criterion or a reference value as a method for measuring trends in water quality or loads (USEPA, 1991b).

## 4. Site Locations

Within any given budget, site location is a function of water resource type (see The Water Resource), monitoring objectives (see Monitoring Objectives), experimental design (see Types of Experimental Designs), the parameters to be monitored (see Parameter Selection), sampling techniques (see Sampling Techniques and Samples and Sampling), and data analysis plans (see Data Analysis). Additional considerations in site selection are accessibility and landowner cooperation.

It is recommended that monitoring stations be placed near established gauging stations whenever possible due to the extreme importance of obtaining accurate discharge measurements. Where gauging stations are not available but stream discharge measurements are needed, care should be taken to select a suitable site. Brakensiek et al. (1979) provide excellent guidance regarding runoff measurement, including the following selected recommendations regarding site selection:

- Field-calibrated gauging stations should be located in straight, uniform reaches of channel having smooth beds and banks of a permanent nature whenever possible.
- Gauging stations should be located away from sewage outfall, power stations, or other installations causing flow disturbances.
- Consider the geology and contributions of ground-water flow.
- Where ice is a potential problem, locate measuring devices in a protected area that receives sunlight most of the time.
- Daily current-meter measurements may be necessary where sand shifts occur.

## **5. Sampling Frequency and Interval**

### **a. Sample Size and Frequency**

It is important to estimate early in a monitoring effort the number and frequency of samples required to meet the monitoring objectives. Spooner et al. (1991) report that the sampling frequency required at a given monitoring station is a function of the following:

- Monitoring goals;
- Response of the water resource to changes in pollutant sources;
- Magnitude of the minimum amount of change for which detection with trend analyses is desired (i.e., minimum detectable change);
- System variability and accuracy of the sample estimate of reported statistical parameter (e.g., confidence interval width on a mean or trend estimate);
- Statistical power (i.e., probability of detecting a true trend);
- Autocorrelation (i.e., the extent to which data points taken over time are correlated);
- Monitoring record length;
- Number of monitoring stations; and
- Statistical methods used to analyze the data.

The minimum detectable change (MDC) is the minimum change in a water quality parameter over time that is considered statistically significant. Knowledge of the MDC can be very useful in the planning of an effective monitoring program (Coffey and Smolen, 1990). The MDC can be

estimated from historical records to aid in determining the required sampling frequency and to evaluate monitoring feasibility (Spooner et al., 1987a). MacDonald (1991) discusses the same concept, referring to it as the minimum detectable effect.

The larger the MDC, the greater the change in water quality that is needed to ensure that the change was not just a random fluctuation. The MDC may be reduced by accounting for covariates, increasing the number of samples per year, and increasing the number of years of monitoring. Sherwani and Moreau (1975) stated that the desired frequency of sampling is a function of several considerations associated with the system to be studied, including:

- Response time of the system;
- Expected variability of the parameter;
- Half-life and response time of constituents;
- Seasonal fluctuation and random effects;
- Representativeness under different conditions of flow;
- Short-term pollution events;
- Magnitude of response; and
- Variability of the inputs.

Coastal waters, estuaries, ground water, and lakes will typically have longer response times than streams and rivers. Thus, sampling frequency will usually be greater for streams and rivers than for other water resource types. Some parameters such as total suspended solids and fecal coliform bacteria can be highly variable in stream systems dominated by nonpoint sources, while nitrate levels may be less volatile in systems driven by baseflow from ground water. The highly variable parameters would generally require more frequent sampling, but parameter variability should be evaluated on a site-specific basis rather than by rule of thumb.

In cases where pollution events are relatively brief, sampling periods may also be short. For example, to determine pollutant loads it may be necessary to sample frequently during a few major storm events and infrequently during baseflow conditions. Some parameters vary considerably with season, particularly in watersheds impacted primarily by nonpoint sources. Boating is typically a seasonal activity in northern climates, so intensive seasonal monitoring may be needed to evaluate the effectiveness of management measures for marinas.

The water quality response to implementation of management measures will vary considerably across the coastal zone. Pollutant loads from confined livestock operations may decline significantly in response to major improvements in runoff and nutrient management, while sediment delivery from logging areas may decline only a little if the level of pollution control prior to section 6217 implementation was already fairly good. Fewer samples will usually be needed to document water quality improvement in watersheds that are more responsive to pollution control efforts.

Sherwani and Moreau (1975) state that for a given confidence level and margin of error, the necessary sample size, and hence sampling frequency, is proportional to the variance. Since the variance of water quality parameters may differ considerably over time, the frequency requirements of a monitoring program may vary depending on the time of the year. Sampling frequency will need to be greater during periods of greater variance.

There are statistical methods for estimating the number of samples required to achieve a desired level of precision in random sampling (Cochran, 1963), stratified random sampling (Reckhow, 1979), cluster sampling (Cochran, 1977), multistage sampling (Gilbert, 1987), double sampling (Gilbert, 1987), and systematic sampling (Gilbert, 1987). For a more detailed discussion of sampling theory and statistics, see *Samples and Sampling*.

### **b. Sampling Interval**

A method for estimating sampling interval is provided by Sherwani and Moreau (1975). They note that the least favorable sampling interval for parameters that exhibit a periodic structure is equal to the period or an integral multiple of the period. Such sampling would introduce statistical bias. Reckhow (1979) points out that, for both random and stratified random sampling, systematic sampling is acceptable only if "there is no bias introduced by incomplete design, and if there is no periodic variation in the characteristic measured." Gaugush (1986) states that monthly sampling is usually adequate to detect the annual pattern of changes with time.

### **c. Some Recommendations**

It is generally recommended that the sampling of plankton, fish, and benthic organisms in estuaries should be seasonal, with the same season sampled in multiyear studies (USEPA, 1991a). The aerial coverage and bed density for submerged aquatic vegetation (SAV) vary from year to year due to catastrophic storms, exceptionally high precipitation and turbidity, and other poorly understood natural phenomena (USEPA, 1991a). For this reason, short-term SAV monitoring may be more reflective of infrequent impacts and may not be useful for trend assessment. In addition, incremental losses in wetland acreage are now within the margin of error for current detection limits. It is recommended that SAV and wetland sampling be conducted during the period of peak biomass (USEPA, 1991a).

The frequency of sediment sampling in estuaries should be related to the expected rate of change in sediment contaminant concentrations (USEPA, 1991a). Because tidal and seasonal variability in the distribution and magnitude of several water column physical characteristics in estuaries is typically observed, these influences should be accounted for in the development of sampling strategies (USEPA, 1991a).

For monitoring the state of biological variables, the length of the life cycle may determine the sampling interval (Coffey and Smolen, 1990). EPA (1991b) recommends a minimum of 20 evenly spaced (e.g., weekly) samples per year to document trends in chemical constituents in watershed studies lasting 5 to 10 years. The 20 samples should be taken during the time period (e.g., season) when the benefits of implemented pollution control measures are most likely to be observed. For benthic macroinvertebrates and fish, EPA recommends at least one sample per year.

## **8. Sampling Techniques**

### **a. Automated Sampling to Estimate Pollutant Loads**

Typical methods for estimating pollutant loads include continuous flow measurements and some form of automated sampling that is either timed or triggered by some feature of the runoff hydrograph. For example, in the Santa Clara watershed of San Francisco Bay, flow was continuously monitored at hourly intervals, wet-weather monitoring included collection of flow-composite samples taken with automatic samplers, and dry-weather monitoring was conducted by obtaining quarterly grab samples (Mumley, 1991). Data were used to estimate annual, wet-weather, and dry-weather copper loads.

In St. Albans Bay, Vermont, continuous flow and composite samples were used to estimate nutrient loads for trend analysis (Vermont RCWP, 1984). In the Nationwide Urban Runoff Program (NURP) project in Bellevue, Washington, catchment area monitoring included continuous gauging and automatic sampling that occurred at a preset time interval (5 to 50 minutes) once the stage exceeded a preset threshold (USEPA, 1982b).

### **b. Grab Sampling for Pollutant Loads**

Grab sampling with continuous discharge gauging can be used to estimate load in some cases. Grab sampling is usually much less expensive than automated sampling methods and is typically much simpler to manage. These significant factors of cost and ease make grab sampling an attractive alternative to automated sampling and therefore worthy of consideration even for monitoring programs with the objective of estimating pollutant loads.

Grab sampling should be carefully evaluated to determine its applicability for each monitoring situation (Coffey and Smolen, 1990). Nonpoint source pollutant concentrations generally increase with discharge. For a system with potentially lower variability in discharge, such as irrigation, grab sampling may be a suitable sampling method for estimating loads (Coffey and Smolen, 1990). Grab sampling may also be appropriate for systems in which the distribution of annual loading occurs over an extended period of several months, rather than a few events. In addition, grab sampling may be used to monitor low flows and background concentrations.

For systems exhibiting high variability in discharge or where the majority of the pollutant load is transported by a few events (such as snowmelt in some northern temperate regions), however, grab sampling is not recommended.

### **c. Habitat Sampling**

EPA recommends a procedure for assessing habitat quality where all of the habitat parameters are related to overall aquatic life use support and are a potential source of limitation to the aquatic biota (Plafkin et al., 1989). In this procedure, EPA begins with a survey of physical characteristics and water quality at the site. Such physical factors as land use, erosion, potential nonpoint sources, stream width, stream depth, stream velocity, channelization, and canopy cover are addressed. In addition, water quality parameters such as temperature, dissolved oxygen, pH, conductivity, stream type, odors, and turbidity are observed.

Then, EPA follows with the habitat assessment, which includes a range of parameters that are weighted to emphasize the most biologically significant parameters (Plafkin et al., 1989). The procedure includes three levels of habitat parameters. The primary parameters are those that

characterize the stream "microscale" habitat and have the greatest direct influence on the structure of the indigenous communities. These parameters include characterization of the bottom substrate and available cover, estimation of embeddedness, and estimation of the flow or velocity and depth regime. Secondary parameters measure the "macroscale" and include such parameters as channel alteration, bottom scouring and deposition, and stream sinuosity. Tertiary parameters include bank stability, bank vegetation, and streamside cover.

MacDonald (1991) discusses a wide range of channel characteristics and riparian parameters that can be monitored to evaluate the effects of forestry activities on streams in the Pacific Northwest and Alaska. MacDonald states that "stream channel characteristics may be advantageous for monitoring because their temporal variability is relatively low, and direct links can be made between observed changes and some key designated uses such as coldwater fisheries." He notes, however, that "general recommendations are difficult because relatively few studies have used channel characteristics as the primary parameters for monitoring management impacts on streams."

On the other hand, MacDonald concludes that the documented effects of management activities on the stability and vegetation of riparian zones, and the established linkages between the riparian zone and various designated uses, provide the rationale for including the width of riparian canopy opening and riparian vegetation as recommended monitoring parameters. Riparian canopy opening is measured and tracked through a historical sequence of aerial photographs (MacDonald, 1991). Riparian vegetation is measured using a range of methods, including qualitative measures of vegetation type, visual estimations of vegetation cover, quantitative estimations of vegetation cover using point- or line-intercept methods, light intensity measurements to estimate forest cover density, stream shading estimates using a spherical densiometer, and estimates of vegetation density based on plot measurements.

Habitat variables to monitor grazing impacts include areas covered with vegetation and bare soil, stream width, stream channel and streambank stability, and width and area of the riparian zone (Platts et al., 1987). Ray and Megahan (1978) developed a procedure for measuring streambank morphology, erosion, and deposition. Detailed streambank inventories may be recorded and mapped to monitor present conditions or changes in morphology through time.

To assess the effect of land use changes on streambank stability, Platts et al. (1987) provide methods for evaluating and rating streambank soil alteration. Their rating system can be used to determine the conditions of streambank stability that could affect fish. Other measurements that could be important for fisheries habitat evaluations include streambank undercut, stream shore water depth, and stream channel bank angle.

#### **d. Benthic Organism Sampling**

Benthic communities in estuaries are sampled through field surveys, which are typically time-consuming and expensive (USEPA, 1991a). Sampling devices include trawls, dredges, grabs, and box corers. For more specific benthic sampling guidance, see Klemm et al. (1990).

**e. Fish Sampling**

For estuaries and coastal waters, a survey vessel manned by an experienced crew and specially equipped with gear to collect organisms is required (USEPA, 1991a). Several types of devices and methods can be used to collect fish samples, including traps and cages, passive nets, trawls (active nets), and photographic surveys. Since many of these devices selectively sample specific types of fish, it is not recommended that comparisons be made among data collected using different devices (USEPA, 1991a).

**f. Shellfish Sampling**

Pathobiological methods provide information concerning damage to organ systems of fish and shellfish through an evaluation of their altered structure, activity, and function (USEPA, 1991a). A field survey is required to collect target organisms, and numerous tissue samples may be required for pathobiological methods. In general, pathobiological methods are labor-intensive and expensive (USEPA, 1991a).

**g. Plankton Sampling**

Phytoplankton sampling in coastal waters is frequently accomplished with water bottles placed at a variety of depths throughout the water column, some above and some below the pycnocline (USEPA, 1991a). A minimum of four depths should be sampled. Zooplankton sampling methods vary depending on the size of the organisms. Devices used include water bottles, small mesh nets, and pumps (USEPA, 1991a).

**h. Aquatic Vegetation Sampling**

Attributes of emergent wetland vegetation can be monitored at regular intervals along a transect (USEPA, 1991a). Measurements include plant and mulch biomass, and foliar and basal cover. Losses of aquatic vegetation can be tracked through aerial photography and mapping.

**i. Water Column Sampling**

In estuaries and coastal waters, chemical samples are frequently collected using water bottles and should be taken at a minimum of four depths in the vertical profile (USEPA, 1991a). Caged organisms have also been used to monitor the bioaccumulation of toxic chemicals.

Physical sampling of the water column at selected depths in estuaries is done with bottles for temperature, salinity, and turbidity, or with probes for temperature and salinity (USEPA, 1991a). Current meters are used to characterize circulation patterns.

**j. Sediment Sampling**

Several types of devices can be used to collect sediment samples, including dredges, grabs, and box corers (USEPA, 1991a). Sampling depth may vary depending on the monitoring objective, but it is recommended that penetration be well below the desired sampling depth to prevent sample disturbance as the device closes (USEPA, 1991a). EPA also recommends the selection of sediment samplers that also sample benthic organisms to cut sampling costs and to permit better statistical analyses relating sediment quality to benthic organism parameters.

**k. Bacterial and Viral Pathogen Sampling**

For estuaries and coastal waters it is recommended that samples be taken of both the underlying waters and the thin microlayer on the surface of the water (USEPA, 1991a). This is recommended, despite the fact that standardized methods for sampling the microlayer have not been established, because research has shown bacterial levels several orders of magnitude greater in the microlayer. In no case should a composite sample be collected for bacteriological examination (USEPA, 1978).

Water samples for bacterial analyses are frequently collected using sterilized plastic bags or screw cap, wide-mouthed bottles (USEPA, 1991a). Several depths may be sampled during one cast, or replicate samples may be collected at a particular depth by using a Kemmerer or Niskin sampler (USEPA, 1978). Any device that collects water samples in unsterilized tubes should not be used for collecting bacteriological samples without first obtaining data that support its use (USEPA, 1991a). Pumps may be used to sample large volumes of the water column (USEPA, 1978).

## **9. Quality Assurance and Quality Control**

Effective quality assurance and quality control (QA/QC) procedures and a clear delineation of QA/QC responsibilities are essential to ensure the utility of environmental monitoring data (Plafkin et al., 1989). Quality control refers to the routine application of procedures for obtaining prescribed standards of performance in the monitoring and measurement process. Quality assurance includes the quality control functions and involves a totally integrated program for ensuring the reliability of monitoring and measurement data.

EPA's QA/QC program requires that all EPA National Program Offices, EPA Regional Offices, and EPA laboratories participate in a centrally planned, directed, and coordinated Agency-wide QA/QC program (Brossman, 1988). This requirement also applies to efforts carried out by the States and interstate agencies that are supported by EPA through grants, contracts, or other formalized agreements. The EPA QA program is based on EPA order 5360.1, which describes the policy, objectives, and responsibilities of all EPA Program and Regional Offices (USEPA, 1984).

Each office or laboratory that generates data under EPA's QA/QC program must implement, at a minimum, the prescribed procedures to ensure that precision, accuracy, completeness, comparability, and representativeness of data are known and documented. In addition, EPA QA/QC procedures apply throughout the study design, sample collection, sample custody, laboratory analysis, data review (including data editing and storage), and data analysis and reporting phases.

Specific guidance for QA/QC is provided for EPA's rapid bioassessment protocols (Plafkin et al., 1989) and for EPA's Ocean Data Evaluation System (USEPA, 1991a). Standardized procedures for field sampling and laboratory methods are an essential element of any monitoring program.

## **D. Data Needs**

Data needs are a direct function of monitoring goals and objectives. Thus, data needs cannot be established until specific goals and objectives are defined. Furthermore, data analyses should be planned before data types and data collection protocols are agreed upon. In short, the scientific

method, defined as "a method of research in which a problem is identified, relevant data gathered, an hypothesis formulated, and the hypothesis empirically tested" (Stein, 1980), should be applied to determine data needs. Types of data generally needed for nonpoint source monitoring programs will include chemical, physical, and biological water quality data; precipitation data; topographic and morphologic data; soils data; land use data; and land treatment data. The specific parameters should be determined based on site-specific needs and the monitoring objectives that are established.

Under EPA's quality assurance and quality control (QA/QC) program (see Quality Assurance and Quality Control), a full assessment of the data quality needed to meet the intended use must be made prior to specification of QA/QC controls (Brossman, 1988). The determination of data quality is accomplished through the development of data quality objectives (DQOs), which are qualitative and quantitative statements developed by data users to specify the quality of data needed to support specific decisions or regulatory actions. Establishment of DQOs involves interaction of decision makers and the technical staff. EPA has defined a process for developing DQOs (USEPA, 1986).

# **Appendix 12**

## **Example Site Location Form** **(courtesy of Alliance for the Chesapeake Bay)**



Office Use Only  
**Monitoring Coordinator:** \_\_\_\_\_  
**Site Designation:** \_\_\_\_\_  
**Tributary:** \_\_\_\_\_  
**Date Site Information entered into database:** \_\_\_\_\_

## ACB Citizen Monitoring Site Documentation

**Instructions:** Please fill in this form as fully and accurately as possible. The information you provide will be used to document monitoring site locations. Be as descriptive as you can. We need to have precise site documentation to enable the location of your site in the future. In each of the Sections, circle the option that applies.

SITE NAME: \_\_\_\_\_  
 PRIMARY MONITOR'S NAME: \_\_\_\_\_  
 BACK-UP MONITOR'S NAME: \_\_\_\_\_  
 DATA COLLECTION START DATE: \_\_\_\_\_

### I. Location Description: (Please Circle)

Tidal                      Nontidal                      Lake  
 Water body (What Creek, Stream, River, Lake the site is on)

Other Location \_\_\_\_\_

Details: \_\_\_\_\_

### II. Collection Description: (Please Circle)

Shoreline                      Pier/Dock                      Bridge crossing  
    Boat                      Wading to Stream Center

### III. Coordinates:

\*A USGS 7-minute quadrangle map or a GPS Unit are the recommended methods for determining site coordinates. You can find all USGS quadrangle maps online for free by going to [www.topozone.com](http://www.topozone.com). You may search by place name or by river name by choosing the link titled "Place Name Search" under "Get A Map". Once you have located your site, you may zoom in by clicking on the 1:25,000 button in the top left corner above the map. Use your mouse to click on the exact location- a red crosshair will appear over your site. Choose "DD.DDDD" (decimal degrees) as the coordinate type located beneath the map. The coordinates will then be listed in these units above the map. You can then either print the map, or email it to us. You can also find USGS maps for local areas at libraries, fishing and camping stores, and engineering and architectural supply stores. Cost is about \$3.00 a map.

**Please Put in Units in Decimal Degrees (DD.DDDD)**

**LATITUDE:** \_\_\_\_\_

(Example: 37.1234)

**LONGITUDE:** \_\_\_\_\_

(Example: -77.1234)

☐ MAP- Please attach a map of your site to this form, with the site labeled.\*

☐ PHOTO DOCUMENTATION- It is recommended that you visually document your site with photographs of the monitoring location looking upstream and downstream. Label the photos accordingly, and attach copies to this form.

(Updated 11/18/02)

## **Appendix 13**

### **Handout from Virginia Water Monitoring Council's Quality Assurance/Quality Control Forum**

## Basic QA/QC Concepts

Modified from *The Volunteer Monitor's Guide to Quality Assurance Project Plans*. EPA 841-B-96-003. September 1996. This guide is recommended for all citizen monitoring organizations in Virginia interested in developing a quality assurance project plan. The guide is available online at [www.epa.gov/owow/monitoring/volunteer/](http://www.epa.gov/owow/monitoring/volunteer/).

### Quality Assurance (QA)

Refers to a broad plan for maintaining quality in all aspects of a program, including all quality control measures, sample collection, sample analysis, data management, documentation, evaluation, *etc.* It is helpful to data users in determining the integrity (soundness) of data.

### Quality Control (QC)

The steps, including measurements, calibrations, and standardization practices, taken to assure the quality of specific sampling and analytical procedures. QC is used to reduce error in the data collection and analysis. For example, the collection of two samples (QC samples) taken at the same time and location should yield the same (or very similar) results; data quality can be determined by evaluating the results of the QC samples and determining precision and accuracy. The decision to accept data, reject it, or accept only a portion of it should be made after analysis of the QC data.

### Quality Assurance Project Plan (QAPP)

The formal written document describing the detailed quality assurance procedures and QC activities that will be used to assure data quality.

### Precision

Degree of agreement among repeated measurements. Reproducible results are precise. Can be calculated using the standard deviation (a statistical way to measure variation around the data set's average value).

### Accuracy

Measures how close your results are to a *true* value. The smaller the difference between the measurement and its "true" value, the more accurate the measurement. Found by analyzing a standard or reference sample (one with a known value).

### Representativeness

The extent to which measurements actually depict the true condition being evaluated. For example, data collected just below a pipe outfall are not representative of the entire stream.

### Completeness

The number of samples and documentation needed to meet the sampling objectives. Volunteers may not be able to collect as many samples as planned so try to take more samples than you expect to need.

### **Comparability**

The extent to which data from one study can be directly compared to either past data obtained in the study or from data obtained in another study.

### **Detection Limit**

In general, the lowest concentration of a given parameter your method or equipment can reliably detect and report as greater than zero. For example, if an instrument has a detection limit of 1 ppb (parts per billion) and a sample contains 0.5 ppb of lead, the sample will be “below the detection limit.” Note, this does not mean the sample is free of lead (0 ppb), simply that the amount of lead is less than the instrument can detect.

### **Metadata**

Metadata is data about the data. It describes the data information presented in a given dataset and quality criteria associated with their generation. Metadata is all other data collected that is not the actual value of the parameter measured. Metadata provides information on the procedures used, quality control measures, site locations, sample collectors, quality of the data, etc.

### **Standard Operating Procedures (SOPs)**

Written instructions, which describe the step-by-step procedures for a process. For example, the procedures for collecting a water sample are referred to as field SOPs while the procedures for analyzing the sample in a lab are referred to as the lab SOPs.

Information provided by the **Virginia Water Monitoring Council (VWMC)**. To join the VWMC, contact **Jane Walker** at **540-231-4159** or [vwmc@vt.edu](mailto:vwmc@vt.edu). A special thank you to DEQ for assistance with this handout.



## **Appendix 14**

# **Quality Assurance Project Plan Template**

This quality assurance project plan template (from EPA 1996, *The Volunteers Monitor's Guide to Quality Assurance Project Plans*) can be used as you develop your Quality Assurance Project Plan for the Department of Environmental Quality DEQ). Please consult other data users to determine if use of this form (or a modified version) is acceptable to them.

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## 1. Title and Approval Page

<div style="text-align: center;"><hr/> (Project Name) <hr/> (Responsible Agency) <hr/> (Date)</div>	
Project Manager Signature	
	Name/Date
Project QA Officer Signature	
	Name/Date
USEPA Project Manager Signature	
	Name/Date
USEPA QA Officer Signature	
	Name/Date

## 2. Table of Contents

List sections with page numbers, figures, tables, references, and appendices (attach pages).

## 3. Distribution List

Names and telephone numbers of those receiving copies of this QAPP. Attach additional page, if necessary.

i.	_____
ii.	_____
iii.	_____
iv.	_____
v.	_____
vi.	_____
vii.	_____
viii.	_____
ix.	_____
x.	_____

## 4. Project/Task Organization

List key project personnel and their corresponding responsibilities.

Name	Project Title/Responsibility
	Advisory Panel (contact)
	Project Manager
	QA Officer
	Field/Sampling Leader
	Laboratory Manager/Leader

## 5. Problem Definition/Background

### A. Problem Statement

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### B. Intended Usage of Data

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## 6. Project/Task Description

### A. General Overview of Project

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### C. Project Timetable

Activity	Projected Start Date	Anticipated Date of Completion

## 8. Measurement Quality Objectives

### A. Data Precision, Accuracy, Measurement Range

Matrix	Parameter	Measurement Range	Accuracy	Precision

### B. Data Representativeness

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### C. Data Comparability

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### D. Data Completeness

Parameter	No. Valid Samples Anticipated	No. Valid Samples Collected & Analyzed	Percent Complete

## 8. Training Requirements and Certification

### A. Training Logistical Arrangements

Type of Volunteer Training	Frequency of Training/Certification

### B. Description of Training and Trainer Qualifications

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## 9. Documentation and Records

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## 10. Sampling Process Design

### A. Rationale for Selection of Sampling Sites

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## B. Sample Design Logistics

	Type of Sample/ Parameter	Number of Samples	Sampling Frequency	Sampling Period
Biological				
Physical				
Chemical				

## 11. Sampling Method Requirements

Parameter	Sampling Equipment	Sampling Method

## 12. Sample Handling and Custody Procedures

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### 13. Analytical Methods Requirements

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### 14. Quality Control Requirements

#### A. Field QC Checks

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#### B. Laboratory QC Checks

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#### C. Data Analysis QC Checks

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### 15. Instrument/Equipment Testing, Inspection, and Maintenance Requirements

Equipment Type	Inspection Frequency	Type of Inspection

## 16. Instrument Calibration and Frequency

Equipment Type	Calibration Frequency	Standard or Calibration Instrument Used

## 17. Inspection/Acceptance Requirements

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## 18. Data Acquisition Requirements

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## 19. Data Management

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## 20. Assessment and Response Actions

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## 21. Reports

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## 21. Data Review, Validation, and Verification

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## 22. Validation and Verification Methods

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## 23. Reconciliation with DQO=s

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## **Appendix 15**

### **Determining the Expiration Date of Some Commonly Used Reagents**

**(courtesy of Alliance for the Chesapeake Bay)**

## Determining the Expiration Date of Some Commonly Used Reagents

This Appendix is used by the Alliance for the Chesapeake Bay to determine the expiration date of the reagents used by organizations using the Alliance's protocols (LaMotte Dissolved Oxygen and pH test kits).

### How to determine "expiration date" of chemicals:

Assuming that chemicals have been stored properly (cool, dark place- not exposed to long periods of sunlight or heat), the chemicals, even once opened should be good for as long as the shelf life indicated in Table 1.

**Table 1**

Chemicals	Shelf Life (years)
Manganese Sulfate	3
Alkaline Azide	3
Starch	18 months
Sulfuric Acid (and powder)	2
Sodium Thiosulfate	1
Chlorophenol Red	2
Phenol red	2
Cresol Red	2
Wide Range indicator	2
Bromcresol	2
Thymol Blue	2
Bromthymol Blue	2
LaMotte Yellow	2

To determine the date that your chemicals were made, look at the first 3 digits in the lot number listed on your chemical label.

Example:

Chemical- sulfuric acid  
Lot No. 1002345

The first 2 digits indicate the week of the year in which the chemicals were made. The 3<sup>rd</sup> digit indicated the year in which the chemicals were made. So this bottle of sulfuric acid was made in the 10<sup>th</sup> week of 2000. Based on the table above, this chemical should be good until the 10<sup>th</sup> week of 2002, or the beginning of March 2002, using the calendar for 2001.

## **Appendix 16**

### **Dissolved Oxygen Saturation Concentrations**

## Dissolved Oxygen Saturation Concentrations

Example: If your water temperature at a freshwater site is 5.1 °C, the potential dissolved oxygen (DO) level (highest DO concentration possible) is 12.71 mg/l. See the next page for compensating for barometric pressure. If the barometric pressure in this example is 760 mm Hg, then your correction factor is 1.00, which makes the potential DO 13.71 mg/l.

Temp in °C	O <sub>2</sub> concentrations in mg/l									
	0	.1	.2	.3	.4	.5	.6	.7	.8	.9
5	12.75	<b>12.71</b>	12.68	12.65	12.61	12.58	12.55	12.52	12.48	12.45
6	12.42	12.39	12.36	12.32	12.29	12.26	12.23	12.20	12.17	12.14
7	12.11	12.08	12.05	12.02	11.99	11.96	11.93	11.90	11.87	11.84
8	11.81	11.78	11.758	11.72	11.69	11.67	11.64	11.61	11.58	11.55
9	11.53	11.50	11.47	11.44	11.42	11.39	11.36	11.33	11.31	11.28
10	11.25	11.23	11.20	11.18	11.15	11.12	11.10	11.07	11.05	11.02
11	10.99	10.97	10.94	10.92	10.89	10.87	10.84	10.82	10.79	10.77
12	10.75	10.72	10.70	10.67	10.65	10.63	10.60	10.58	10.55	10.53
13	10.51	10.48	10.46	10.44	10.41	10.39	10.37	10.35	10.32	10.30
14	10.28	10.26	10.23	10.21	10.19	10.17	10.15	10.12	10.10	10.08
15	10.06	10.04	10.02	9.99	9.97	9.95	9.93	9.91	9.89	9.87
16	9.85	9.83	9.81	9.79	9.76	9.74	9.72	9.70	9.68	9.66
17	9.64	9.62	9.60	9.58	9.56	9.54	9.53	9.51	9.49	9.47
18	9.45	9.43	9.41	9.39	9.37	9.35	9.33	9.31	9.30	9.28
19	9.26	9.24	9.22	9.20	9.19	9.17	9.15	9.13	9.11	9.09
20	9.08	9.06	9.04	9.02	9.01	8.99	8.97	8.95	8.94	8.92
21	8.90	8.88	8.87	8.85	8.83	8.82	8.80	8.78	8.76	8.75
22	8.73	8.71	8.70	8.68	8.66	8.65	8.63	8.62	8.60	8.58
23	8.57	8.55	8.53	8.52	8.50	8.49	8.47	8.46	8.44	8.42
24	8.41	8.39	8.38	8.36	8.35	8.33	8.32	8.30	8.28	8.27
25	8.25	8.24	8.22	8.21	8.19	8.18	8.16	8.15	8.14	8.12
26	8.11	8.09	8.08	8.06	8.05	8.03	8.02	8.00	7.99	7.98
27	7.96	7.95	7.93	7.92	7.90	7.89	7.88	7.86	7.85	7.83
28	7.82	7.81	7.79	7.78	7.77	7.75	7.74	7.73	7.71	7.70
29	7.69	7.67	7.66	7.65	7.63	7.62	7.61	7.59	7.58	7.57
30	7.55	7.54	7.53	7.51	7.50	7.49	7.48	7.46	7.45	7.44

Barometric Pressure Corrections:

mm Hg.	Correction Factor	mm Hg.	Correction Factor	mm Hg	Correction Factor
760	<b>1.00</b>	735	0.967	710	0.934
755	0.993	730	0.96	705	0.927
750	0.987	725	0.953	700	0.92
745	0.98	720	0.947	695	0.914
740	0.973	715	0.94	690	0.907